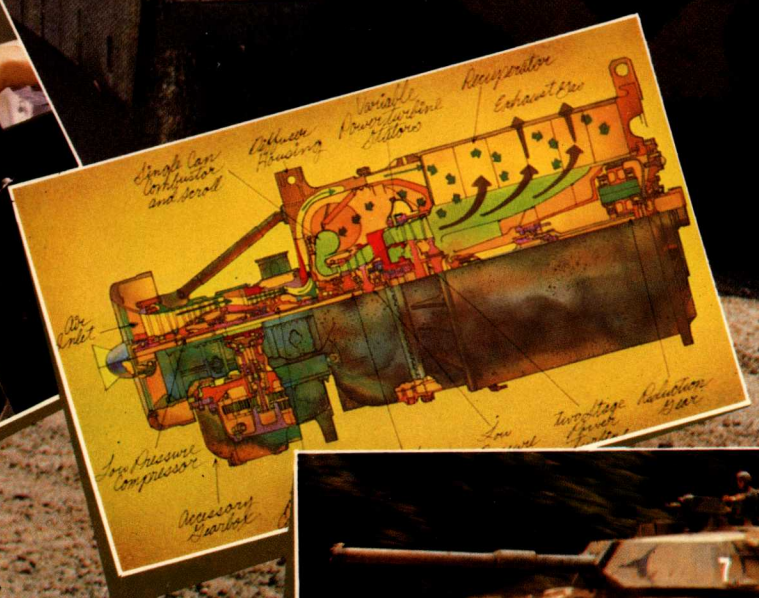
Vol. VII · Issue 10 · 1983

ISSN 0722-3226

MILITARY TECHNOLOGY

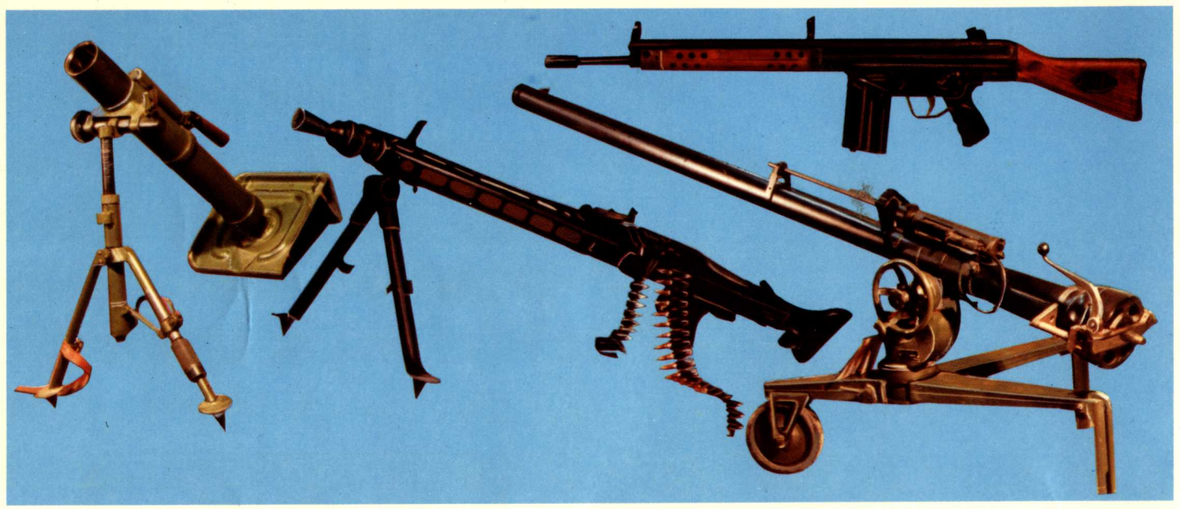
MILTECH

RPVs and Drones



Naval Guns

Strategic air reconnaissance



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No. 10/83 · Oct. 1983

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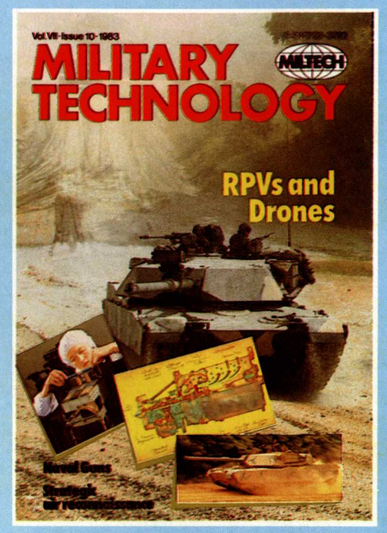

The front cover shows the American M-1 ABRAMS main battle tank which will be one of the main exhibits at the AUSA Exhibition to be held this year between 11 and 13 October in Washington. This tank, after a series of tough proving trials, is being delivered to the US Army both in the US and in Germany where it will complement the M-60A3 in the defence of NATO. The M-1 outperforms the present generation of American tanks and will be given extra firepower with the addition of a 120 mm gun in the near future.

Military Technology presents in the next issue **No. 11 — November 1983**

JAPAN — the giant awakes

Night combat techniques and sighting systems

Pyrotechnics for the armed forces

and as a separate supplement SWEDEN: the defence of a neutral nation

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Subscriptions
MILITARY TECHNOLOGY is published 12 times annually. This periodical is available by subscription for DM 96,—, inclusive postal charges (surface), per year. Orders must be accompanied by check or international money order, payable to Wehr + Wissen. Air mail rates on request. Change of address: Please send old mailing label and new address together with name of journal to Mönch Publishing Group, P.O. Box 140261 in D-5300 Bonn 1 (West Germany) and allow two months for change to become effective.

Subscriptions U.S.A. and Canada
MILITARY TECHNOLOGY is published twelve times per year by Wehr + Wissen Verlag, Bonn, West Germany. The subscription price is US $ 48.00 per annum. Application to mail at Second-Class rates is pending at Englewood, N.J. 07631. **Postmaster:** Send address changes to: Monch Media, Inc., 1309 Vincent Place, McLean, VA 22101. — Subscribers: Please use same address for orders and payments.

Verlag Wehr + Wissen GmbH, HRA 1061 Koblenz
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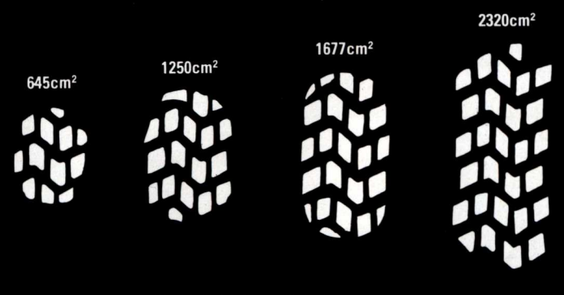

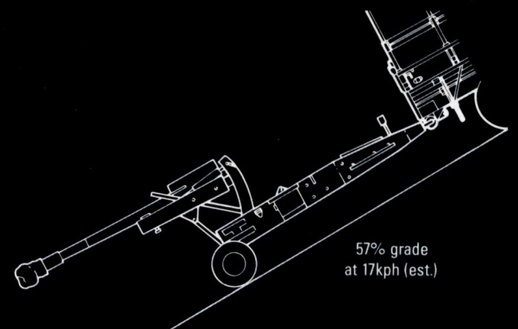

M923 Towing a 7.2 metric ton M198 Howitzer

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Will we never learn?

The death of 269 innocent people, condemned and swiftly executed for the crime of — as Mr. Gromyko put it — "violating the sacred border of Soviet Union" is a sad argument which cannot be allowed to pass without some comments in this column.

Readers are of course well aware of the course of the tragedy — which, by the way, some circles have already started to call an "incident" — and they will have their own opinions about who actually gave the order to shoot down the Korean 747, about whether Soviet air defence forces could really have mistaken the Jumbo for an RC-135 (and if so, how long) and about whether the whole affair could not have been a calculated move of warmongers in the Soviet military circles to embarrass the Kremlin and force it on a hawkish path. But although of key importance to understanding what actually happened, and why, these points are not of relevance there. What is to be underlined is that the shooting down of the 747 shows again that Soviet Union is a peculiar world in itself with its own rules, behaviours and reactions — things that, although clearly demonstrated on many occasions, are still not fully understood in the West.

You have to know your (potential) enemy; and that means not only ascertaining how many tanks, aircraft and warships he has, but — much more important, particularly in our times — understanding how his mental processes work, and how he will react under a crisis situation. Now, what does the Soviet decision to cold-bloodedly kill 269 civilians tell us about them?

Nothing really new — they have behaved that way since the October Revolution; but we keep forgetting, and this could lead to "surprises" far worse than the shooting down of a civilian aircraft.

First of all, the Soviets have a nearly hysterical concept of their security, both as a country and as an ideology. No matter how strategically sensitive the Kamchatcka/Sakhalin area is, and no matter whether the Soviets actually mistook the 747 for an RC-135 (or believed that the Jumbo was carrying out a spying mission on its own), it is obvious that anyone in the Soviet military above the private level should know that the US obtains nearly all the information it wants through reconnaissance satellites; if these are not sufficient, a short-life satellite will be put in a low orbit; and if even more detailed information is needed, an SR-71 could easily "violate the sacred borders" with absolute impunity. The possibility that an *electronic* spy plane such as the RC-135, or a plain 747 could have by will or by chance picked up information which was not already available in the US, or that the US could not have obtained through other means, was exceedingly remote. The aircraft was shot down simply because "you never know".

This attitude is extremely telling, and an accurate analysis of it could have far-reaching implications. For instance, the Soviets are now threatening that they could retaliate to the positioning of PERSHING 2 missiles in West Germany by adopting a "launch on warning" approach. But if they are prepared to shoot down a civilian aircraft simply because it "should not have been there", and because of an extremely

remote possibility of the betrayal of some of their secrets, then they are certainly already now on a "launch on warning" posture — and this has to be carefully considered in our strategic plans. Also, we have to realise than any Western move which the Soviets could perceive as a direct threat to them could trigger an overreaction far exceeding our guesses. This does not mean that we should not make that move, if we believe it is necessary, for fear of the Soviets; but simply that we have to calculate that their reactions could well go very far.

Even more important is the way in which the Soviet managed the crisis (or attempted to do so). Once the upper political levels in the Kremlin knew about the fact they basically had two main choices:

a) continue to deny indefinitely and against all evidence that they knew anything about the fate of the Korean aircraft;

b) immediately admit the truth, blame some idiot along the command chain and offer apologies and compensation. They would have actually had nothing important to lose in doing so.

It took six days of agony for the Kremlin to decide what to do and here we have a first indication of extreme importance: very poor reflexes and very bad crisis management. How this Soviet leadership could manage a really serious and sudden crisis is a matter of somber speculation.

And then, they finally decided to follow what in Western eyes was the worst possible approach: admit that they actually shot down the aircraft, immediately adding however that the Jumbo was "guilty" anyway (if not of spying, then of "violation"), and that consequently they were fully right to act that way and that they will do so again under similar circumstances.

This attitude created a world outcry against Soviet Union to a far higher level than the tragedy in itself; actually, it is just this attitude which will prevent the tragedy from being totally classed as an "incident" and from swiftly fading away, for the world could eventually have accepted a human error accompanied by apologies but could never tolerate the Soviet stubborn refusal to admit moral responsibility. And it is obvious that the Soviets knew that.

Their reaction was automatic and instinctive — although it took six days to materialise. The very harsh statements with which Mr. Shultz announced to the world the Soviet "unexcusable, barbaric crime" were of course fully justified, but they reinforced the Soviet firm conviction that theirs is a country besieged and encircled both politically and militarily and under constant threat from its ideological foes — and that the only way to react to Western accusations was to out on a sense of self-righteousness against everyone and anyone.

It is only too easy to underline that the Soviet attitude is repulsive and totally out of line with the rules of decent political life, but it is also of no use at all. We have to realise that this attitude is not the result of a sudden spread of folly within the Kremlin, but a nearly inevitable result of their ideas about the Soviet Union and the rest of the world. They are going to defy the whole world's opinion, and accept being considered as mad trigger-happy killers from Canada to Singapore, only to avoid having to say "Mr. Shultz was right". Not only are they probably serious when they say that they will do it again: we can *count* on them doing the same again.

The fact that a May-La affair or a "Vietnam syndrome" are totally impossible within Soviet Union was, of course, already well known. But this was generally assumed to be a result of the ease with which the Kremlin can manipulate internal public opinion; on the contrary, it is now evident that there is no way in which they can feel guilty of even the worst crimes, if security is assumed to play a role and (even more important) if the West points the finger against them. It is also evident that the great majority of the Soviet population shares the Kremlin's point of view, and will quite probably continue to do so even if the full facts were known.

This leads us to the way the US had handled the crisis. Some US commentators have pointed out that President Reagan is acting exactly oppositely to the way Teddy Roosevelt suggested: he is speaking loudly, but only carries a walking stick. To a certain extent, this is unfortunately true. Granted, it is also true that arms limitation talks and (more or less) peaceful coexistence are far more important than the life of 269 — or 269,000, for that matter — people; but the point seems to have escaped us that all the amount of blame being hurled against the Soviets is of no practical use at all — except that it will entrench their mental attitude of even more "All the world is gainst us and is threatening us. Let's show them that we're not afraid!".

The 269 people who died over Sakhalin have offered us a priceless psychological analysis of the Soviet leadership: as we cannot unfortunately bring them back to life, let's at least not throw away their extreme legacy.

Manfred Sadlowski

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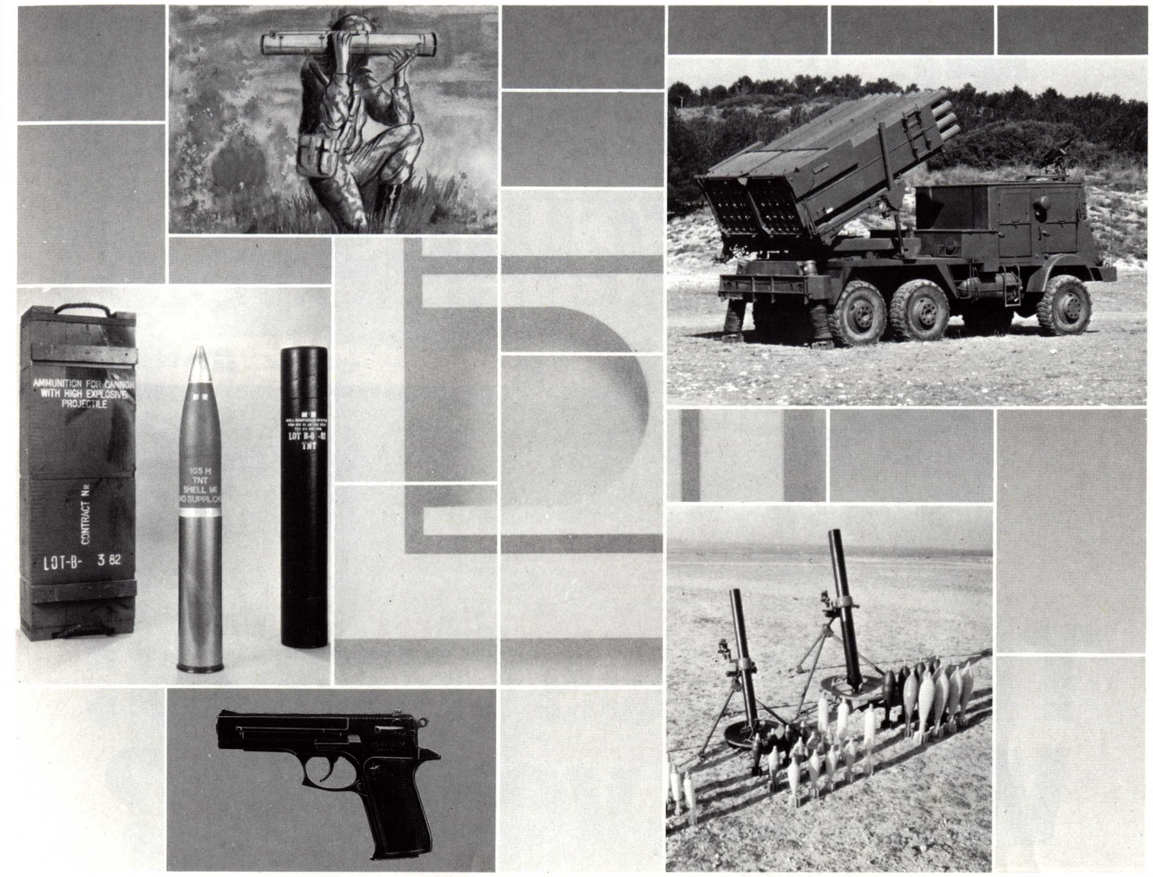

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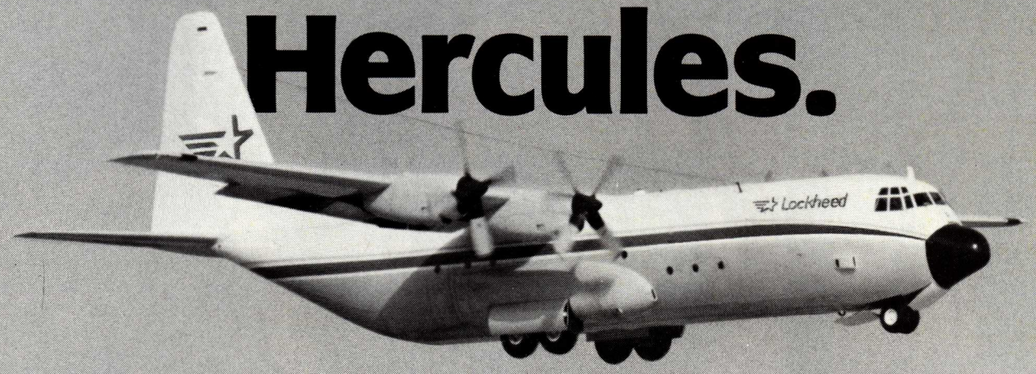

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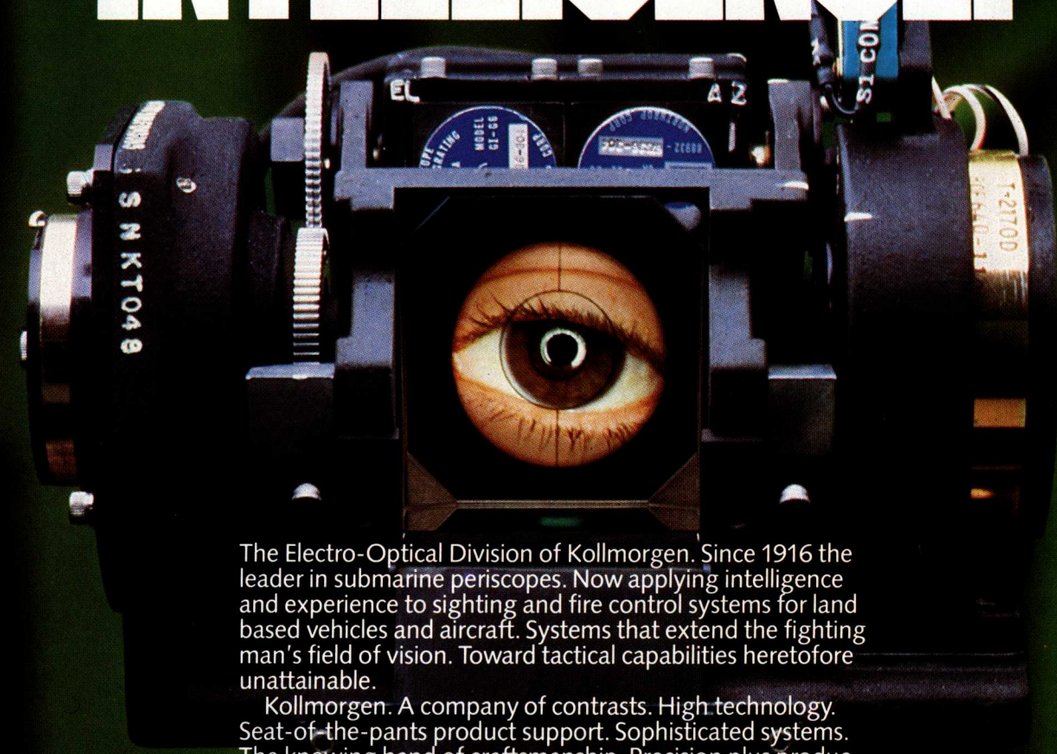

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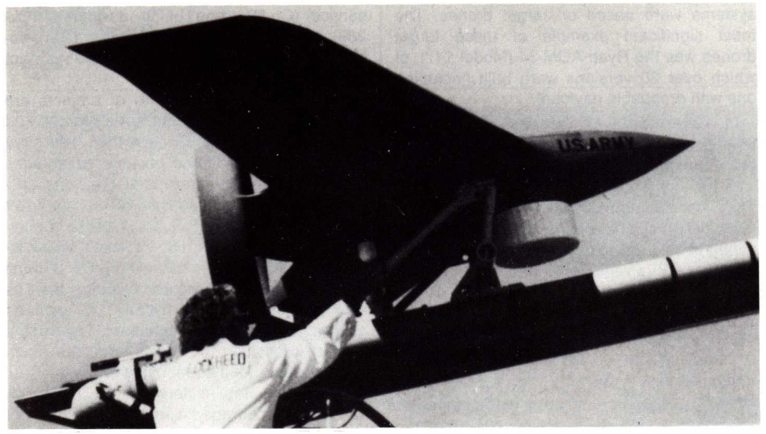


The latest version of the Lockheed AQUILA RPV. They are being designed to locate and provide targets for artillery weapons including the MLRS which has just entered production.

- ☐ saturation of enemy air defence by using decoy RPVs,
- ☐ communication (relay function, C^3, over-the-horizon),
- ☐ air strike against fixed radiating targets (defence suppression, as well as suppression of enemy C^3 capability),
- ☐ air strike against vehicles (especially the enemy's second echelon),
- ☐ transport.

In the following some of these missions are examined in more detail; the state of the art of RPV development can be seen from a number of systems described below.

Targets

As already mentioned, one of the primary and prevalent uses of drones is as targets. Since these are not very spectacular training and testing equipment, their development has gone largely unheeded. Target drones are available for all speed ranges up to Mach 2 (in part derived from tactical guided missiles) and with take-off weights up to around 1,000 kg.

Current developments focus on increasing the payload to improve the simulation of particular targets, as well as on reducing costs by using composite materials and advanced microelectronics. Hence the NV-144 being developed by the Ventura Division of Northrop costs only one third to one half of the almost 30-year-old BQM-34 FIREBEE I which it could replace in the U. S. and foreign armed forces.

One particular aspect of drones as targets is the conversion of jets (mostly ones which have been taken out of service) for extreme manoeuvring, mostly guided from the ground. This technology was already used in Germany before 1945, and it is still used today in the U. S. for optimum training of pilots in air-to-air engagements.

In Germany there has been no target drone developed, with the exception of the KZD (Kleinzieldrohne) mini-target drone from Topp. The KZD had proved itself but has in the meantime been taken out of service. Testing and training with surface-to-air missiles is done on foreign ranges, where the necessary targets are provided.

Reconnaissance

The armies of most countries have had a long-standing need for their own aerial reconnaissance systems for three reasons. First, present-day area weapons cause the enemy units to disperse. Second, advanced precision weapons require direct target assignment, and third, too much time elapses between the mission assignment and the results when manned aerial reconnaissance is used.

How are RPVs used for aerial reconnaissance today? Despite their excellent suitability (low level flight over enemy territory) and positive results achieved with RPVs in Vietnam, fully operational RPVs are in service only with the armies of West Germany, Great Britain, Italy and France (all use the CL-89), Belgium (EPERVIER) and especially Israel (SCOUT, MASTIFF). The German armed forces have had a leading role in using RPVs, considering their introduction into service of the first system and also their overall concept of army reconnaissance.

CL-89 (NATO designation AN/USD-501)

The development of the reusable and mobile CL-89 by Canadair as main contractor to Canada, Great Britain and West Germany pioneered the way for the concept of other systems, and not just for reconnaissance. The CL-89 entered service in the German armed forces in 1972. Its task is situation reconnaissance and battlefield surveillance (and to a certain extent also target detection) in both day and night at the division level.

With a launch weight (without booster) of 112 kg, the drone can penetrate about 50 km, or 65 km with an auxiliary tank. The jettisonable booster propels the drone to a speed of 760 km/h in 2.5 seconds. This speed is then maintained by a turbojet engine. The airborne computer is programmed with the necessary data (especially the points to be overflown and the strips to be reconnoitered), and also provides flight guidance and controls the camera. Except during landing approach, the drone cannot be externally guided and is thus completely resitant to any enemy ECM. A radio beacon controls the final approach and the landing is done with parachutes and air cushions.

The payload consists either of an optical automatic camera (three lenses) or an infrared linescanner (IRLS). The film must be removed after landing and developed before it can be evaluated. Under most favourable conditions only 60 to 80 minutes are required from mission assignment to reporting of the first results; the target can be engaged at the earliest 40 minutes after overflight by the RPV.

Since 1970 the German Army has carried out more than 1,700 flights with the CL-89; the results have been termed very satisfactory.

CL-289 (NATO designation AN/USD-502)

The CL-289 is a follow-on project to the CL-89, and resembles the latter in construction and mission programme. The bilateral project between Canada and the Federal Republic of Germany began in 1976. The work was shared equally between Canadair as the main contractor and Dornier as the main sub-contractor. France joined the project in 1977 and contracted SAT to develop the IRLS sensor and the associated jam-proof data transmission system.

The CL-289 is used for target and situation reconnaissance at the corps level, and is to remain in service beyond the year 2000. It offers

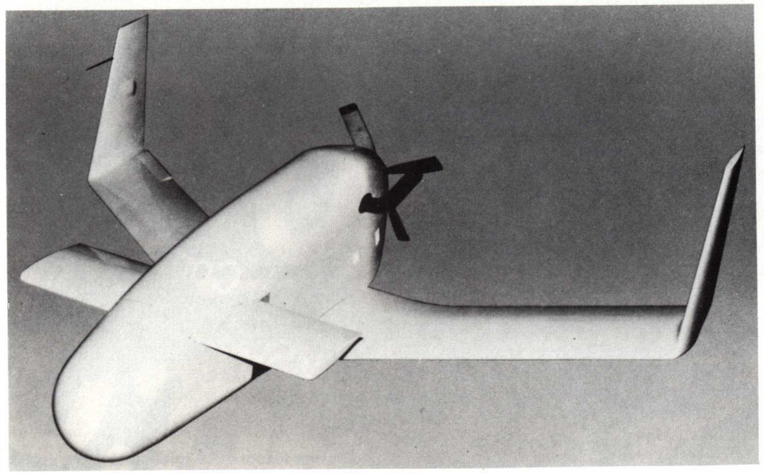
The photograph shows the Teledyne Ryan FIREBEE together with a variety of the weapons and sensors it can carry including a MAVERICK air-to-ground missile. The FIREBEE first flew in 1960 and is still in use today.

the following improvements over the CL-89: greater penetration; sufficient payload capacity for two sensors at the same time; high degree of navigational accuracy and low influence of wind due to use of doppler radar; real-time data transmission of IR pictures; higher flexibility in pre-programming the flight path; more frequent change of course, frequent switching on and off of sensors. Naturally these better capabilities lead to more weight, and also to the necessity for new developments of many system components. Nevertheless there are significant similarities with the CL-89 in terms of procedure, training and material maintenance.

ARGUS

The ARGUS (Autonomes Radar-Gefechtsfeld-Überwachungs-System = autonomous radar battlefield surveillance system) was developed for stand-off reconnaissance. The system consists of a KIEBITZ tethered rotor platform from Dornier and the French ORPHEE II radar sensor LCT (Laboratoire Central de Télécommunications). The system is designed to gather, prepare and transmit data on enemy movements. The ground station is designed to gather, prepare and transmit data on enemy movements. The ground station is housed in a ten ton cross-country truck.

ARGUS is to be deployed at the division level. Reconnaissance depth is approximately 60 km over a 180° azimuth. The system is operable under all weather conditions (however, wind speed may not exceed 22 m/s), and for more than 24 hours. The KIEBITZ platform has a reaction rotor; the rotor's twin blades are driven by cold air expanded through the blade-tip nozzles. The cold air is provided by a compressor driven 300 kW Allison 250 gas turbine. The blades are controlled cyclically and collectively. Thrusters provide control around the vertical axis. Complete stabilisation is ensured by an autopilot with an inertial system. A platform with a shaft-driven double rotor, such as the Dornier Mini-Telecopter could increase the reconnaissance range through higher altitude, and also at the same time reduce the vulnerability of the ground station by the greater mobility of the platform.



The PAVE TIGER from Boeing. Capable of carrying various payloads such as ECM packages, warheads and sensors, it is designed to attack high priority targets.

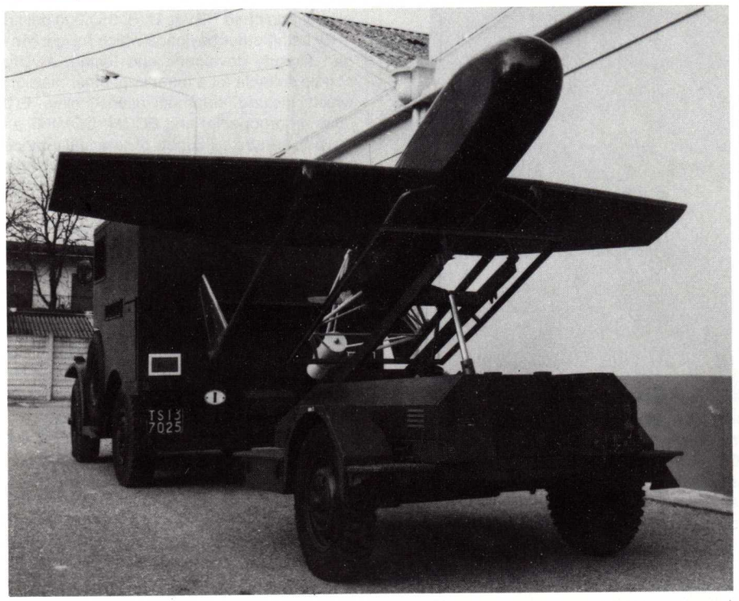
The ORPHEE II is a coherent pulse doppler radar with moving target indication for detection of moving targets. It can rotate around the vertical axis. Highly accurate slaving (several angular minutes) of the antenna in elevation and azimuth is another feature of the radar.

Radar data and the exact position of the platform (tether length and angular deviation) are transmitted to the control system. On a screen are displayed a synthetically produced real-time display corrected for position and, by storing the radar data over a particular time, additional information can be yielded and displayed. Together with the planned automatic data transmission, ARGUS provides the combat centre the current enemy situation of the entire division sector round the clock. For the first time the urgent requirement for large-scale real-time reconnaissance for the army can be met.

Target detection

The increasing mobility of targets, especially for the artillery necessitates a type of reconnaissance which cannot be fulfilled with the systems described above: the provision of real-time target information enabling immediate and precise engagement of these targets and, as far as possible, assessment of damage. Only in this way can the efficiency of the tube and missile artillery, including terminally guided projectiles, be increased to the extent necessary. There is international interest in such systems offering appreciably longer loitering times as well as greater coverage than conventional systems. This interest is demonstrated by the number of projects in the concept stage: PHOENIX (UK), SKORPION (France) and KZO (West Germany). The Italian Meteor MIRACH 20 is also completing its development phase. Development of the U. S.

The launch of a CT 22 Drone manufactured by Aerospatiale of France. This drone is capable of towing, successively two targets during the course of one flight. It is expected to equip all french firing ranges in the coming years.



The MIRACH-20 which, its manufacturers Meteor claim, is the first mini-RPV system to be entirely manufactured in Europe. It has the by now almost typical tail boom/pusher propeller configuration and as it is seen mainly in the battlefield surveillance/target designation role can carry a variety of equipment such as stabilised TV, FLIR plus laser, panoramic camera and IRLS. it is launched from a trailer, normally towed by a 4 × 4 truck which is its control station and the take off is rocket assisted, the recovery being by net. The MIRACH-20 belongs to the larger ANDROMEDA family to which belong the highly aerodynamic MIRACH-70 and 100 RPVs. The flight of the MIRACH-20 can be controlled either from the ground or have the flight evolutions programmed into it. The first batch of these RPVs will be produced this year.

highly precise navigation. It allows pre-programming of waypoints, courses and altitudes, which can be overridden from the ground control system at any time on the basis of the transmitted video image or other information.

Another emphasis in development will be the sensor payload and its integration in the RPV, the flight control and data transmission. A thermal imager will probably be preferred to a TV camera due to the requirement for night capability. As in the case of the AQUILA, the second sensor will be a laser illuminator/laser rangefinder, as well as a video sensor on a stabilised platform. Launch and recovery systems should probably not represent any developmental risk.

The price of the KZO will be largely determined by the requirements for the sensor package. Jam-free data transmission and flight control are additional cost factors, against which the RPV and the ground system is only a small amount, even though it is more expensive than expendable systems due to the fact that it is reusable, and highly reliable. The KZO RPV will thus probably cost over half a million marks.

Like the ARGUS, the KZO will be a component of reconnaissance in the German Army. These components, integrated into an overall system, would give the German armed forces a complete reconnaissance, surveillance and fire control capability by the end of the 80s, an absolute necessity for engaging an enemy offensive with superior numbers.

Air strike

The idea of an air strike RPV, mainly for air force missions, was already investigated during the 70s in studies which also led to prototypes. Those concepts foresaw completely reusable RPVs for attacking heavily defended ground targets with externally mounted bombs and missiles. They differed from manned fighter bombers only in dispensing with those airborne systems necessary for human interface, as well as supersonic capability. Thus these concepts involved weights of several tons, the missions differed only slightly from interdiction/strike missions, which they were in part to replace.

Present-day concepts of airstrike RPVs are based exclusively on small, fully automatic expendable systems which are inexpensive enough to produce in large numbers. Concept studies have already led to complete development of such weapon systems: these include the LOCUST harassment drone, the SUPERFLY mini-drone, (against communication systems) and PAVE TIGER.

In mission profile, ground-launched cruise missiles armed with conventional warheads, which have already started to enter service, correspond to this category of RPV. The configuration of this type of RPV however, represents an intermediate sector between unmanned aircraft and a missile.

Before a technical description of the airstrike concept is presented, it would be useful to briefly examine the idea of an airstrike with unmanned vehicles in light of the overall strategic situation during a possible conflict in Europe. According to prevailing opinion in NATO, the Warsaw Pact strategy is based on occupying or at least destroying all important Western installations, including the C^3 I systems, in a surprise mass offensive. Thus for Western defence the necessary requirements are the capability of inflicting heavy losses on the attacking forces within the first 24—48 hours and the availability of weapon systems which can immediately be deployed even with an unfunctional C^3 I system, since it cannot be guaranteed that the C^3 I system will remain intact.

These conditions are best and certainly most cost-effectively fulfilled by unmanned drones of the LOCUST type all the way up to GLCMs. The longer range and more expensive GLCMs should be deployed for example against bridges, aircraft shelters and similar critical targets, while mine-drones are intended for the many less hardened targets such as radar installations and C^3 I installations. Anti-tank drones would be suitable in creating heavy buildups of vehicles on the already overfilled enemy advance routes with just a few hits.

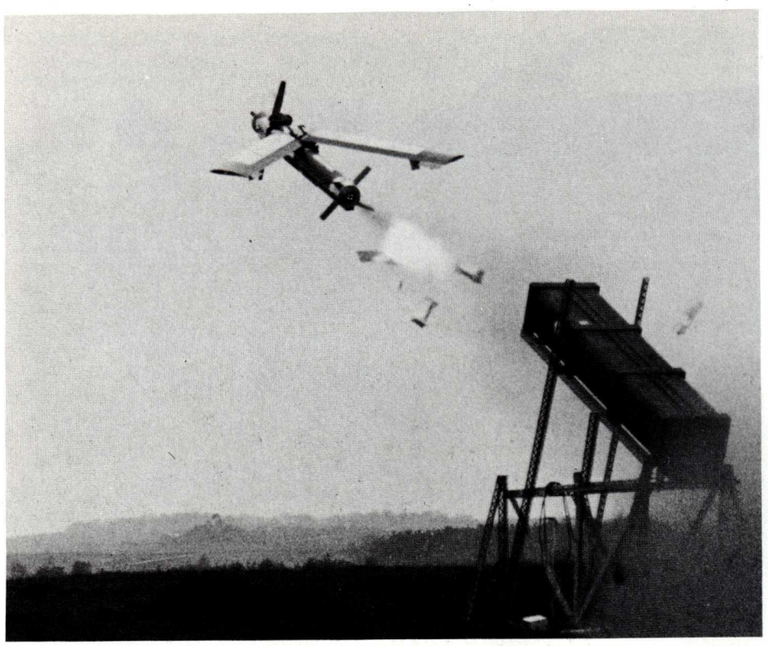
LOCUST

The LOCUST concept (formerly known as the Harassment weapon system) demonstrates as does hardly any other system the capabilities and the cost-efficiency of deploying mini-drone systems in Europe. Its target is suppression of enemy air defence in order to greatly reduce the risk for manned ID/S missions. Launched at high speed (and hence from transport containers), and in great numbers these mini-drones armed with a passive radar seeker and a warhead fly toward the predetermined target area beyond the FEBA with only a relatively approximate autonomous navigation. They loiter until they acquire an emitting radar emplacement, and then attack. Should the radar be switched off because of the threat (which would also fulfill the mission), the LOCUST drone immediately begins to loiter and search at a higher altitude: if the radar cannot be acquired again, it continues the final phase according to the most recently received signals.

The German-American agreement of 1979 on joint development covered sharing the work and costs 50:50. Contracts for warhead development went to General Dynamics and Texas Instruments; three other teams of firms, General Dynamics/VFW Fokker, Texas Instruments/Dornier and Teledyne Brown/MBB competed for the RPV itself and system integration. The feasibility of the project was demonstrated by the preliminary work up to flights of the RPVs (of all three German firms) as well as terminal flights with warheads. The firms invested a considerable amount of their own capital in the project. However, before the contracts could be awarded, the German side was forced to withdraw from the project in May 1981 due to budgetary restrictions. As far as is known, the U. S. also dropped the project.

SUPERFLY and PAVE TIGER

These two U. S. projects have the same mission characteristics as the LOCUST, and are aimed at enemy C^3 I systems. Direction finding of a weak signal in the VHF range is more difficult with a small warhead of 20—25 cm diameter than in the radar range, but its feasibility was proven in 1979 by the U. S. Army SUPERFLY programme. Prototypes from E-Systems with warheads from Motorola carried a small explosive charge; take-off weight was under 40 kg. In two terminal flights against a truck with an antenna mounted on the roof, the antenna itself was hit once, and the other drone im-



The MBB/Teledyne LOCUST harassment drone being launched directly from its container which is used for transport and storage. It is a small drone capable of approaching a target area, searching out radar targets and destroying them.

pacted less than 3 m away. Even though this programme reached its goal it was not continued.

Since the end of 1982 there have been brief reports about the PAVE TIGER project, which was originally funded by Boeing and is now a U. S. Air Force development project. Its deployment as part of the quick reaction capability is intended to support strikes of manned combat aircraft against high priority targets. Targets are jammers and other sources of radiation; the seeker is to be developed by E-Systems. The RPV has already been flight-tested by Boeing; it has a wingspan of only around 2.60 m and is powered by a 28 hp piston engine.

Even though there does not seem to be any general revitalisation of the Harassment RPV concept, the PAVE TIGER project seems to indicate that there has been some rethinking done in the U. S., obviously after the Israeli successes in Lebanon.

Current status

The present-day situation can be characterised as follows:

- ☐ The important technologies are available:
  - — inexpensive airframe construction
  - — engines suitable for the various missions (inexpensive ones for expendable systems, reliable ones for reusable and/or expensive systems, e. g. CM)
  - — launch and landing procedures
  - — ground systems including control stations
  - — digitalised flight control including autonomous navigation
  - — jam-free data transmission
  - — sensors.
- ☐ There have been considerable advancements in the miniaturisation of electronic components and their cost will probably continue to drop.
- ☐ There is a wide spectrum of applications which, however, are only slowly being accepted by their potential users. Payloads have already been developed for most missions.
- ☐ The main emphasis is clearly on mini-RPVs/drones; flight weights of a maximum of 100—120 kg are by no means system optimised. However, they do not promise the lowest possible costs for development and production, and hence enable large-scale production.
- ☐ Prices for mini-RPVs range from $20,000—$60,000 for expendable systems and from $150,000—$500,000 (according to payload) for reusable ones.
- ☐ Large RPVs are presently not being considered for deployment for reasons of cost (development risk) and air safety, at least not by European countries.
- ☐ "Replacement" of manned aircraft is not intended and also not foreseeable.

The near future

What are the development trends for unmanned aircraft? This question will be answered for the most important missions and in light of the most significant characteristics of unmanned aircraft.

As targets

There is a requirement for greater reality in simulation of actual target characteristics, which include low-level, high speed flight; formation flight; manoeuvring; ECM/ECCM capability.

Reconnaissance, target acquisition and fire control

Evolutionary progress in existing systems or ones being developed can be expected:

All weather (and not just night) capability, for example through the availability of millimeter radars.

Further reduction of expenditures for ground systems with speed up of partial procedures through automation (for example the reconnaissance evaluation system of the CL-89 and CL-289 — one of the most time-consuming tasks done manually today).

Use of the fire control capability also for weapons launched by manned aircraft, and — further in the future? — of strike RPVs.

Continuation of the trend of man as part of the control circuit. Only in this way can the information being transmitted be used for optimum command and control of the same flight.

Air strike

Here a distinction should be made between stationary and moving targets. Currently the first generation of cruise missile is going into service for potential deployment against stationary targets. The following development trends can be noted in mini-RPVs/drones:

— stationary targets: only targets which radiate come into question here, and thus missions and designs are similar to those of the LOCUST. These drones can be improved by further reducing the cost of the airframe; better suitability of engines in terms of cost and weight for non-reusable deployment; optimising the warhead for the particular mission.

— moving targets: The great necessity of rapidly countering the massed strike forces of the Warsaw Pact's second echelon should certainly provide the impetus for pre-concept phase efforts toward a weapon system capable of engaging large numbers of targets and at greater range (›100 km) than the Western armoured forces and precision artillery presently are. An anti-tank drone costing about the same as the LOCUST system, and one which largely uses the development results of this programme, should be feasible. It should also have the capability to be deployed in unreconnoitred areas where a sufficient target concentration is suspected (staging roads, bridges etc.). Such an anti-tank drone would require optimisation of the surveillance flight as well as measures to avoid overkill (engaging the same tank with several drones), and especially sensors for acquisition, classification (tank or truck) and measurement/engagement of the target. Should such an anti-tank drone operate automatically, airborne computers and target acquisition sensors would be required. There are a number of concepts which would be possible for the terminal phase, but all of these utilise the technology (and possibly hardware) of the submunitions being developed for the MLRS programme. The MLRS TGW (terminally guided warhead) could be used in a design with an integral warhead (in this case the drone itself would attack the tank at the steepest possible angle). In combination with a target acquisition sensor such as an acoustic one, the warhead can also be used for target acquisition. An alternative which would not require any other airborne sensor if a millimeter

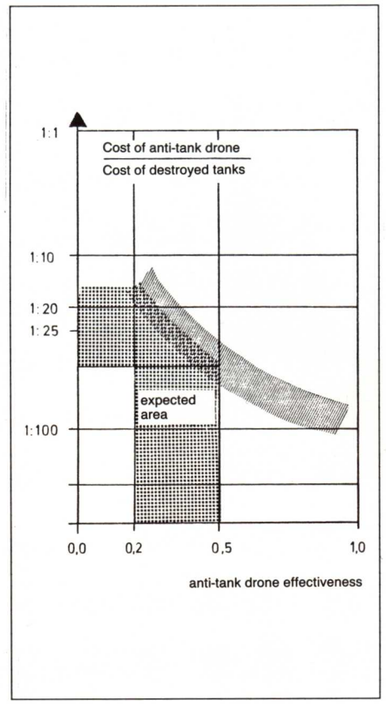
wave radar were used would be to carry two or three complete TGWs, allowing one drone to engage the corresponding number of tanks.

Compared to the MLRS, which fires the TGWs into the target area with unguided rockets, a drone system (using one of the alternatives above) would offer the following advantages:

- ☐ greater range
- ☐ (autonomous) target seeking
- ☐ more flexible flight control
- ☐ disengagement (in the case of the wrong target)
- ☐ much greater accuracy in delivering TGWs (lower CEP).

Looking at cost-effectiveness from the present-day standpoint, which is still fraught with uncertainties, a cost exchange ratio between a tank and a drone can be set up (Fig. 1).

A value of 80 is assumed as an average. The effectiveness of the anti-tank drone is calculated on the basis of the individual probabilities such as with the LOCUST, however excluding real-time acquisitioin probability, which until now can only be assumed to a limited extent. Even under unfavourable assumptions a cost-ratio of at least 20 can be obtained in accordance with this calculation (four drones for every tank destroyed).



Cost exchange ratio

ECM

In describing typical missions for RPVs, a number of EW possibilities were mentioned, which mainly included defence suppression, decoy or saturation. The only systems currently deployed for these missions are Israeli ones. In the sector as a whole there is no lack of concepts and even pay loads which have been developed; on the other hand, however, there has been little determination on the part of potential users as well as insufficient funds to develop such systems.

Two active ECM missions can be mentioned here as examples:

- ☐ decoy RPVs to saturate enemy air defence information systems all the way up to triggering defensive measures against a non-existing threat.
- ☐ radar jammers to reduce the acquisition range of the surface-to-air radar systems. An RPV flying at 250 m, for example, at a range of 6 km requires an output of only 10^{+7} that of a ground jammed 30 km away, and the RPV can jam at even greater ranges behind the FEBA.

Air defence

In the foreseeable future unmanned aircraft will not complement or even replace the current air defence system consisting of missile anti-aircraft and fighter bombers. Automation is hardly sufficiently advanced to fulfil air defence missions, especially identification and selection of highly manoeuvrable targets under EW conditions, nor does current technology allow these missions to be carried out successfully from a distant (ground) control centre. While a future combat aircraft will have to fulfil a variety of missions as part of its air-to-air role, an RPV designed for even part of these missions would scarcely bring any reduction in complexity and costs. Hence the development of an RPV for air defence must still be regarded as a thing of the future.

A general look to the future

Finally, the most important characteristics of unmanned aircraft should be judged in light of their significance in an East-West scenario and for the definition of future weapon systems. Mini-RPVs in particular will be focussed on.

Pilot risk

Many missions cannot be performed by manned aircraft as they entail too great a risk to the pilot. Other missions have a greater chance of success when automatic systems do not have to take a crew into consideration (''Drones are fearless!''); this in turn should cause a not inconsiderable increase in deterrence.

Survivability

The visual, acoustic, radar and IR detectability and hit probability against mini-drones is extremely low, simply on the basis of their small dimensions and capabilities. Radar cross-section is favourably reduced due to the small proportion to metal parts, and stealth technologies should in turn further reduce signatures, just as they do in manned aircraft. The disadvantage of the relatively low flight speed are more than compensated for by their advantages, as well as by a suitable flight profile (up to anti-aircraft profiles). Given the additional measures mentioned and under realistic conditions, a mini-drone, in contrast to a manned aircraft, can only be engaged with a very low kill probability, and relatively (compared to its own cost) high cost.

Cost

Despite the limitations imposed on a direct comparison between manned and unmanned systems due to their fundamental differences, the latter's advantage in regard to cost is undisputable. This is true for procurement, personnel and other operating costs, and especially for fuel costs. However, performance and operational parameters must not be forgotten here. These factors are taken into consideration in a cost comparison (Table 3) between two reconnaissance systems. The manned system costs 1.5 times that of the unmanned one for procurement and personnel, and five times greater to operate, given the same number and quantity and quality of pictures. Even with better availability of the CL-89 system for army command and control, however, the flexibility and penetration of an RF-4E PHANTOM cannot be achieved by a drone. But as long as missions can be fulfilled by unmanned systems, the cost advantage will be on their side.

Progress in technology

Twenty years ago there were still reservations about drones from a technical standpoint. This is no longer the case today, given the present miniaturisation in electronics, which has favourably influenced the development of unmanned systems and their potential spectrum of applications. Such systems are termed ''force multipliers'' by the U. S. They multiply the combat strength of a numerically inferior force at a relatively low cost and with only average complexity and requirements on the operators.

Relation to tactical nuclear weapons (TNW)

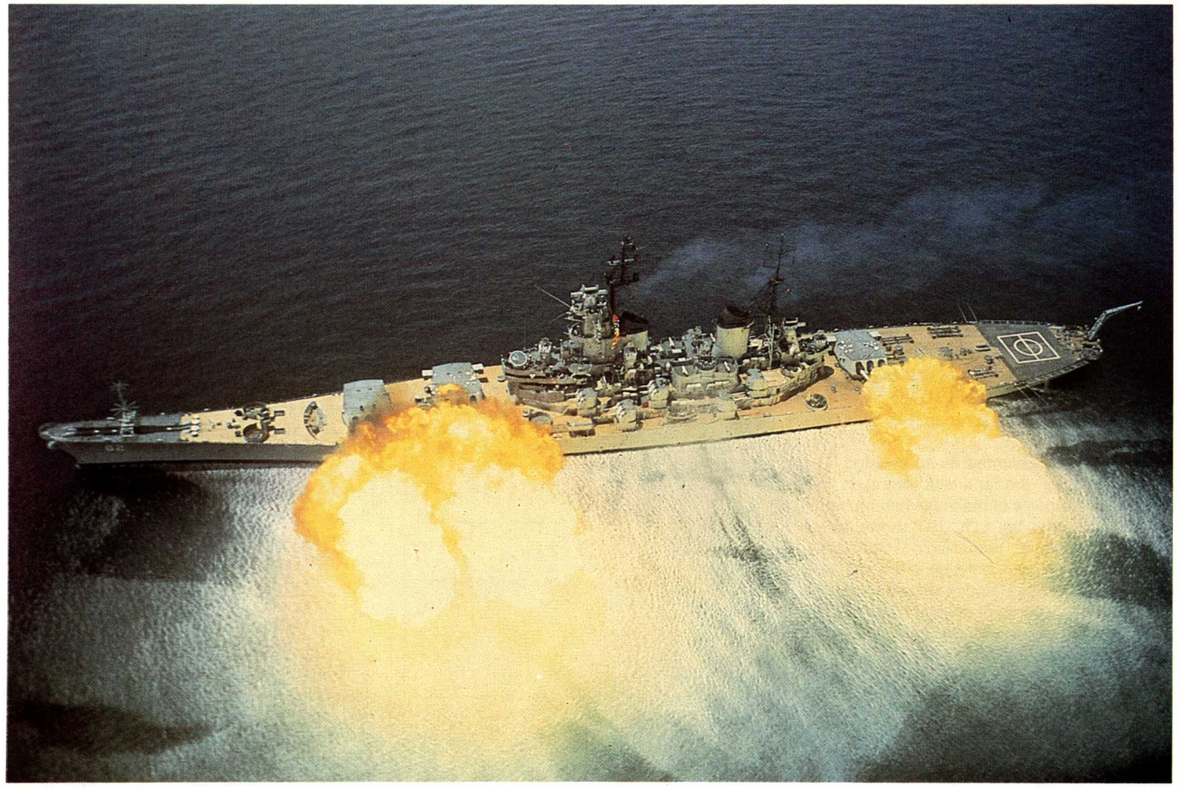
A direct comparison between an RPV and a tactical nuclear warhead can be made, a model being the destruction of a unit of ten enemy tanks. At the same cost and the price of the drone of maximum $50,000 the individual RPV would only require a destruction probability of 0.25. If a theoretical kill probability of 1 is assumed for the RPV and the TNW, the effect of the TNW can be achieved at only one quarter the cost.

Such considerations can also be applied to other applications and demonstrate that drone systems — perhaps the only ones — represent a credible deterrent without resort to nuclear retaliation. They could be the politically most significant means which have been sought for a long time to reduce the nuclear threshold.

Conclusion

The discussions of manned vs. unmanned systems should not focus on the complete replacement of manned systems.

Undoubtedly, however, not only new missions, but also some of the existing manned ones can be fulfilled by RPVs. The state of the art has been achieved through considerable investments in technology and these will continue to play a decisive role in the future. It will depend on military planners to optimally use the limited funding available for the existing potential.



A spectacular image of USS NEW JERSEY firing a full broadside of her nine 406 mm guns. The re-commissioning of NEW JERSEY and of her sistership IOWA will fullfill a long-standing USMC requirement for a truly effective shore bombardment capability.

Ezio Bonsignore

Naval guns: an update and some considerations

Since the early 50s, when naval missiles came of age (originally for surface-to-air applications only, in the West, and for surface-to-surface applications only, in the East), the way in which the different navies evaluated the level of importance to be attributed to naval guns has been marked by ups and down. Much on the same lines, rather diverging ideas existed about the threat(s) a naval gun — providing the gun was judged necessary — should be designed to engage, and consequently about the best tradeoff between its characteristics.

Twice in the past 30 or so years — in the US at first, and much more recently in the UK — the decision was taken to design and build "all missile" naval vessels, with no guns at all or with a symbolic, small caliber artillery component. In both cases, although for quite different reasons, these attempts were recognized as failures, and corrective measures (or design modifications for follow on ships) had to be introduced.

At present, it appears that no Navy is prepared to seriously consider the possibility of building new classes of surface combatants without some kind of medium caliber guns, for medium/short range anti-aircraft defence. However, there still are wide differences of opinion about the tasks that naval artillery can or should perform in modern naval warfare, differences which often far exceed the logical divergences in operational philosophies which result from the missions of each Navy. As a result, surface combatants of more or less the same dimensions and intended for more or less the same operational tasks can be fitted with anything from a single 57 mm gun to two single 127 mm turrets — which makes some difference.

It is also interesting to point out that, for reasons which will be clarified later, there is at least a tentative interest toward larger caliber weapons. The Soviet Union too, which till the late 70s fitted its major naval combatants with small caliber gun, only intended for AA defence, is now fitting dual-role medium-caliber artillery on all its more modern front-line units.

So, it would appear that the naval gun is here to stay. We are also on the verge of a possible (some commentators would say likely) "renaissance" of the naval gun, which could enable it to regain much of the field lost to missiles in the past years. This renaissance is expected to materialise due to the application for naval purposes of two technologies, both of them already proven in ground artillery: namely, terminal guidance and auxiliary propulsion (RAP, Rocket Assisted Projectiles).

General remarks

In broad terms, the tasks which can be entrusted to naval guns are still the traditional ones: air defence, engagement of surface targets, coastal bombardment. As a very first consideration, it is important to point out that as far as the first two applications are concerned, and at least for vessels above a certain minimum size, the artillery is nearly invariably considered as *complementary* to surface-to-air and/or surface-to-surface missiles; this obviously explains why 3,000+ t frigates and 200 t FACs can carry exactly the same "main gun armament".

On the contrary, no true replacement for the naval gun has yet been found as far as coastal bombardment is concerned. This is what the Royal Navy rediscovered in the South Atlantic, and the reason why the US Marine Corps tried for years to bring the IOWA-class battleship back into service. Some different studies have been launched over the years (mainly in the US) in order to develop a suitable large-caliber missile for shore bombardment, but these all failed to show really valid results; it also appears that the current study — project BEACHCOMBER — now has a very low priority after the recommissioning of USS NEW JERSEY and USS IOWA.

So we have three requirements, for which the gun to be embarked on our vessels has to be selected or designed, two of which are heavily dependent on missile systems the gun(s) is intended to back up, and the third, where our gun(s) will represent, to all intents and purposes, the only weapon system available onboard.

It should be said that a particular case of anti-air defence, namely anti-missile defence, has now grown to such operational importance, and requires such highly-specialised weapons, that these gun systems can rightfully be considered as a breed apart. As we have already spoken about this particular aspect of the use of naval artillery (see MT No. 26 page 82), we will not touch on the topic of guns specifically designed for anti-missile defence in this article; however, some implications of anti-missile defence for larger caliber weapons will be touched upon later.

The inherent flexibility of the naval gun, which can be used for three main roles, is of course one of its strongest points — the more so because modern naval vessels are highly restricted in terms of available space and weight. However, this very flexibility also poses some thorny problems, as, for instance the characteristics which optimise a gun for, say, anti-aircraft defence are not of much use when the gun is being used for shore bombardment. At least in present naval construction practice, the idea of fitting two different gun systems is nearly invariably ruled out (apart, of course, from specialised CIWS), the only notable exception being the two Italian AUDACE-class DDGs (two 127 mm and four 76 mm guns). This means that a compromise has to be accepted, selecting either a smaller caliber gun able to provide good results against aircraft — but whose small projectiles are useful only against light vessels, and of nearly no use at all for shore bombardment — or a larger caliber weapon, optimised for anti-ship and coastal bombardment duties but whose rate of fire usually fall short of the minimum requirement for a decent AA barrage fire. From a very theoretical point of view, the second solution should be preferred, because AA defence can be entrusted to other systems while there is no replacement for the gun in the coastal bombardment role and only a very costly replacement for the anti-ship role. However, in practice many navies will believe that the air threat against their vessels is a far more pressing problem than the relatively limited occasions of gunnery duels or shore bombardment.

So (CIWS apart) the typical artillery armament of surface naval combatants from 200 or so up to 10,000 t is found in one or two single gun turrets, with calibers ranging from 57 to 127 mm. Whether this standardisation is the result of a general consensus of opinion, based on sound operational evaluations — or rather the outcome of lack of true experience in modern naval warfare industrial considerations and of cost problems linked to the need to keep dimensions down all combined, is a moot point.

It is generally said that modern naval vessels do not need the impressive artillery panoply of their WW2 counterparts, and can be content with one or two guns, both because part of the tasks once entrusted to guns has now been taken over by missiles (this is of course true) and because the accuracy of modern radar-assisted fire makes up in quality what is lost in quantity (this is only true to a certain extent).

We have already commented that for anti-aircraft and anti-ship applications, naval guns are intended to complement missile systems. This means not only that guns are used to make up some of the shortcomings of missile systems (such as, for instance, a certain minimum engagement range) but also — some would say mainly — that guns are needed to solve one of the most serious problems posed by the missile age: that is, the limited missile reserve available in ships which, although being high-value, are of relatively small dimensions. The importance of this problem cannot be underestimated; the operations in the South Atlantic have been a sober reminder of the appalling intensity of modern air/naval battles, which "burn" ammunition at a previously unknown speed (and the Falkland War was only a pale suggestion of how a future true air/naval battle would look). Of course, replenishment at sea is there just to solve this problem, but it could hardly be practicised under fire. As a result, it is to be feared that a modern frigate or destroyer could well use up all her surface-to-air (and possibly surface-to-surface) missiles in the first hours of a serious large-scale encounter, and would then have to fight with her gun(s) for the rest of the day. This is even more likely because many navies follow operational doctrines and procedures strongly suggesting that all available weapons systems should be used to engage a given serious threat, and that a commander should not try to spare some of these for a later attack.

All this means that guns could very well end up being used, not as a defensive or offensive "layer" complementing the missiles, but as **the** weapon system for anti-air and possibly also for anti-ship applications. And in this context, the current trend of fitting only one or two single turrets appears much more as a result of space and weight constraints than as a carefully balanced decision.

Modern medium-caliber naval guns — Main characteristics

	Country of origin	Manufacturer	Turret weight, loaded (t)	Mount weight (t)	Rate of fire (rounds/min.)	Ready-to-fire rounds	Elevation	Elevation/ training speeds (degrees/sec.)	Elevation/ training accelerations (degrees/sec.^{2})	Muzzle velocity (m/sec.)	Max. horizontal range (m)	Max. altitu (m)
155/50 mm VLNG single	USA	FMC		22.5	10	none	–10°/+75°	50/30	100/60			
130/70 mm twin	USSR	n. a.			65–80		? /+85°				28,000	
127/54 mm single	Italy	OTO Melara	40.6	34	40	66	–15°/+85°	30/40	40/45	808	23,600	13,6
127/54 mm Mk45 single	USA	FMC	25	22.5	20	20	–15°/+65°	20/30	40/60	808	23,600	13,6
127/54 mm Mk42Mod9 single	USA	FMC	63	58	34	40	–15°/+85°	25/40	60/60	808	23,600	13,6
120/46 mm single	Sweden	Bofors		28.5	80	52	–10°/+80°	32/40		800	18,500	
114/55 mm Mk8 single	UK	Vickers		25.75	25		–10°/+55°		40/40	850	21,000	6,0
100/60 mm single	USSR	n. a.					? /–85°				18,000	7,0
100/55 mm Mod. 68 single	France	Creusot-Loire		22	60		–15°/+80°	25/40	80/50	870	17,000	8,0
100/55 mm "Compact"	France	Creusot-Loire	19.5	13.5	90	90+12	–15°/+80°	33/50	95/57	870	17,000	8,0
76/62 mm single	Italy	OTO Melara	8.5	7.4	85	80	–15°/+85°	35/60	72/72	925	16,300	6,0
57/70 mm Mk II single	Sweden	Bofors		6–	220	40 (*) +120	–10°/+75°	40/55	115/115	1020		

rojectile eight g)	Round weight (kg)	Crew	Automatic fire	Built-in optical FC	Peak power consumption (kW)	Material for the shield	Barrel water cooling	Training arc	Max. recoil force (t)
		11	no	no		fiberglass	no		
				yes		steel	yes		
7	47.9	9	yes	no	100	fiberglass	yes	330°	24
7	47.9	6	yes	no	180	fiberglass	no	340°	24
.7	47.9	12	yes	yes	296	fiberglass	no	unlimited	24
	35		yes	no	60	steel	yes	unlimited	
1	36		yes	no	189	fiberglass	no	340°	30
				no		steel	yes		
5	23.8		yes	no	84	steel	yes	350°	11.5
5	23.8		yes	no	84	fiberglass	yes	350°	11.5
	12.3	3	yes	on request	100	fiberglass	yes	unlimited	7
4	6.3	1(*)	yes	no	—	fiberglass	yes	unlimited	

The author recognizes that his creation of a "medium caliber naval gun" category, comprising weapons from 57 up to 155 mm, is arbitrary and does not correspond to any generally agreed standard. However, it was felt that such a category was feasible within the sense and the scope of this article: in general, it could be said that it groups all guns which are, or can be, considered as main artillery armament for naval vessels from corvette size upward.
Some widely diffused gun models, although no longer manufactured, have been included in order to allow comparison with the new models replacing them. Some guns currently in production, but only used to a limited extent (such as the Soviet 76 mm), have not been listed.

(*) The original loading system of the Bofors 57 mm Mkll allows for firing under remote control, not only of the 40 ready-to-use rounds, but of all the 120 rounds stored in the mount. This way, no gun crew is needed.

At the Falklands, it was demonstrated that the widely-held idea that WW2 vintage broadsides could well be replaced by a few accurately aimed shells was a little optimistic; not only has modern radar-assisted fire control not reduced the amount of ammunition a ship should carry to fight and survive, but also — when the whole weight of defence falls back on guns — it is simply not true that a single turret can do the same job as, say, three older twin turrets with optical FC. Anyway, one gun is better than no guns at all, and we will have to live with that.

The anti-aircraft role

In general terms, it could be said that the current doctrines about the use of naval guns in the anti-aircraft role (and, to a large extent, the whole doctrine of shipborne air defence) are still an attempt to solve the old "kamikaze" problem. Kamikazes were a nasty affairs not simply because their pilots were accepting death to press their attacks home, but mainly because they required a complete shift in AA fire tactics. The problem was no longer how to create a sufficiently dense barrage of fire to deter and disrupt massed air attacks (shooting down some enemy aircraft in the process), but rather how to destroy *that* particular aircraft which was being aimed at your ship. The US shipborne surface-to-air missile programme was launched just to cope with this problem.

Although kamikazes are no longer around, the basic point is still more or less the same: when used as anti-aircraft weapons, naval guns are intended to be accurately aimed at a single point target, be it an aircraft or an anti-ship missile. As far as aircraft are concerned, the assumption here is that formation attack is no longer to be expected and that the defences can consequently concentrate their efforts on a target or two at a time. Unfortunately, this assumption leads to weapon systems which have a rather low resistance to saturation, and it will be very interesting to see how much of them will survive an in-depth analysis of the experiences of the Falklands.

Also, it is generally considered that in any likely future aircraft vs. ship battle the aircraft will rely on air-to-surface missiles — which can be launched outside the range of all except the best shipborne AA defence systems — or on guided bombs — which can be released outside range of small caliber guns. This would leave the gun with a rather limited field of action; apart from the fact that the Falklands have shown the risks of tailoring one's own forces for too sophisticated a threat. However, the proponents of the above would perhaps be surprised to learn that the German Marineflieger, after a year of operational evaluations with TORNADO, have concluded that,

after KORMORAN, the best weapon for engaging heavily-defended naval targets are good old iron bombs, delivered with toss bombing techniques.

As far as defence against anti-ship missiles is concerned, naval guns of the category we are considering (that is, between 57 and 127 mm) are mainly used to fill the gap between medium-range surface-to-air missile systems such as SEA SPARROW, ALBATROS/ASPIDE and CROTALE and the anti-missile CIWS. However, the new Bofors 57 mm Mk2 gun can well be considered as an anti-missile system in itself, while retaining a good anti-aircraft and a not irrelevant anti-ship capability.

Irrespective of whether the target is a missile or an aircraft, the effectivess of the gun is largely dependent on three parameters:

a) accuracy (comprising both the gun's dispersion and the precision of its FCS);
b) reaction time (comprising both the aiming and elevation speed and accelerations and the time needed to identify and track the target and to solve the ballistic equation);
c) rate of fire.

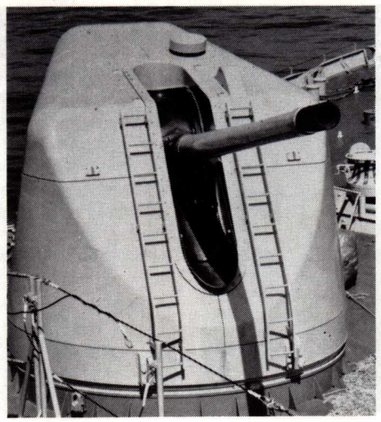
Reaction time and rate of fire compensate for each other, at least to a certain extent. A very fast reacting system will offer interesting performance even with a rather low rate of fire, and vice versa. This is because the engagements are likely to be very short, with a very few seconds available for the whole firing process.

The ammunition in itself is not a particularly important point, in the sense that as a 57 mm shell — if properly aimed — will hit its target, there is no need to use a 127 mm shell. However, ammunition efficiency is directly linked to the caliber — in that a larger caliber shell can contain more explosive charge and hence a greater fuze activation range is possible — and here we face a trade-off between caliber and rate of fire.

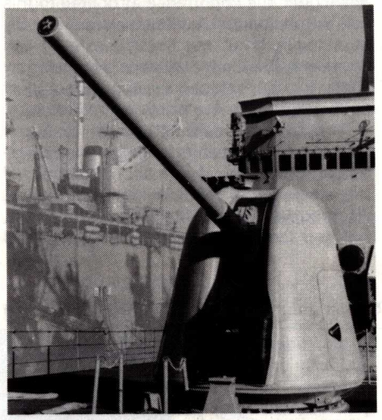
Larger caliber guns not only fire a more powerful ammunition, but have a longer range and consequently allow for starting the engagement sequence well in advance; this not only leaves more time to try to shoot down the attacking aircraft or missile, but — in the case of aircraft armed with stand-off weapons — could well make the difference between whether the target can be engaged with guns at all, or not.

On the other hand, it could be pointed out that there is little sense in opening fire at longer ranges if it is only possible to fire only a few rounds before being hit: unless one is exceedingly confident in one's FCS, with a low rate of fire shooting down a target within a few seconds is mainly a matter of luck. Better to have a smaller caliber gun, open fire later, but be able to fire many more rounds in the engagement time available.

The answer to the question of whether the large caliber/long range/high ammunition efficiency/low rate of fire combination is or is not to be preferred to the smaller caliber reduced range/lower ammunition efficiency/high rate of fire combination varies from navy to navy. Selection of the latter approach undoubtedly strengthens the inner defence layer, and consequently it is, perhaps, the best choice when the main threat is assumed to be anti-ship missiles (either air, surface or submarine-launched); but on the other hand, it leaves the outer defence task completely to surface-to-air missiles. In turn, the former approach emphasized engagement capabilities at medium range — with a rather wide area in which *both* missiles and guns can be used — but leaves close-in defence nearly completely to the anti-missile CIWS.



First embarked on the Canadian DDHs of the IROQUOIS-Class, the OTO Melara 127/54 mm gun was subsequently adopted for some classes of DDGs and frigates of Italian and German construction. Compare the dimensions of the turret with those of the U.S. Mk45.



The FMC Mk45 127/54 mm (seen here onboard a SPRUANCE-Class DD) is now the standard naval gun for US vessels above frigate size. It was designed in the effort to minimize weight, dimensions and manning requirements, even if this meant accepting somewhat lower performance.

A wooden mock-up of the new Bofors 57/70 mm Mk II. Bofors claims that thanks to its rate of fire of 220 rounds/min. and to the newly-developed ammunition, the Mk II offers performance comparable to those of a 100 mm gun. Selection of this gun for the new Canadian frigates (which, at 4,200 ts, could have embarked far larger guns) could well mark a new trend in naval artillery.

Other factors also have a key influence on the selection process. The choice of the caliber also influences the weight and space which must be reserved for the ammunition reserve: for a given space and weight one could select either a larger reserve of smaller caliber rounds or a smaller reserve of larger ones. Again, the choice here is dependent on the perceived threat and on the method which is judged more appropriate to cope with it.

But in any case, for anti-aircraft/anti-missile applications considerable importance must be attributed, not only (as is obvious) to an unmanned fully-automatic gun, but also to a substantial reserve of ready use ammunition which can be fired without human intervention, Given the intensity of modern air/naval battles and the relative ease with which an artillery component, based on a single gun, can be saturated, even a gun with the best ballistic characteristics coupled with an excellent FCS would be of little use if, after a few bursts, the action has to be stopped to reload.

It is easy to see that, even taking only AA use into consideration, the requirements are often conflicting, and a wholly satisfactory trade off between all the parameters is consequently quite difficult to achieve. This was quite probably the main reason behind the large commercial success of the OTO Melara 76/62 mm gun, a very good AA gun with still acceptable performance for anti-ship use, and consequently the best choice for anything from a frigate down to an FPB when AA fire had top priority, anti-ship fire was a less important priority and shore bombardment was not considered as a key requirement. The Canadian decision to adopt the new Bofors 57 mm Mk2 for their new frigates, instead of the originally planned OTO 76 mm, is however, an interesting indication of a possible new trend.

Waiting for terminally-guided rounds, the ammunition used for AA fire is of course fitted with an HE/fragmentation warhead and proximity fuze. Here it could be said that a larger caliber offers the advantages of both the capability to obtain a kill within a larger miss distance and (as a direct consequence of size) a more efficient fuze with a larger activation range can be fitted. However, given the fact that in nearly all cases the target (be it a missile or an aircraft) will be flying very low, and that consequently the activation range of the fuze will have to be reduced in order to prevent premature triggering from sea clutter, it is doubtful whether this advantage could be fully exploited.

Anti-ship role

If the gun complements the missiles in the anti-air role, it does so even more in the anti-ship role. Not only are the number of anti-ship missiles carried onboard strictly limited (usually no more than eight), but these missiles are reserved for really worth-

Two OTO Melara 76/62 mm guns firing from an Italian DDG of the AUDACE Class. The AUDACEs have the strongest artillery component of all modern Western naval combatants, with two 127 mm and four 76 mm guns.

The new Creusot-Loire 100/55 mm "Compact" on the assembly line. The gun, which offers a very interesting rate of fire of 90 rounds/min., has already been exported to Saudi Arabia and Malaysia.

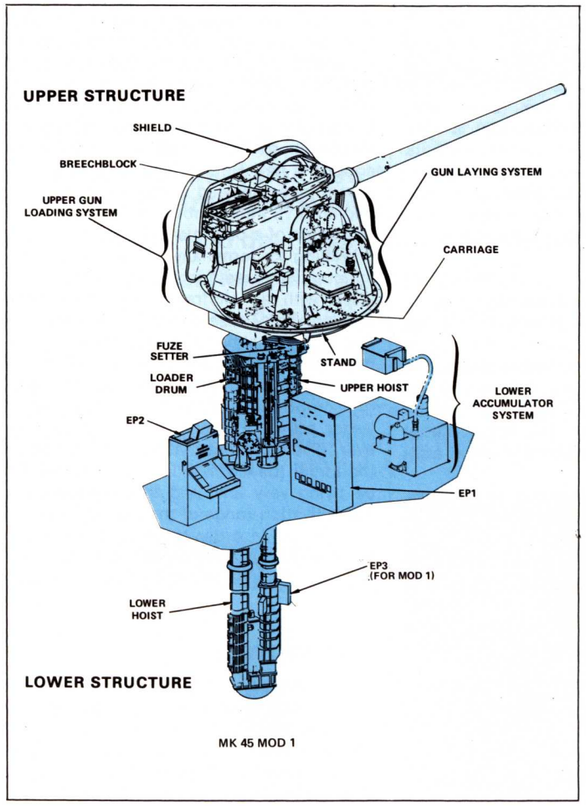
while targets. Thus it is easy to visualise many low threat/low value or low threat/high value targets (such as landing vessels, replenishment and/or merchant units, disabled major combatants) or finally, high threat/low value targets (such as FACs and FPBs) which for different reasons cannot be engaged with anti-ship missiles in a cost-effective way. Also, nearly all anti-ship missiles have a minimum engagement range, and as a result, the gun has a paramount importance in beating off surprise attacks in restricted waters.

This means that at least a certain capability to engage surface targets is (nearly) invariably foreseen in the requirements for a naval gun. The importance attributed to this role in relation to AA defence varies, usually at a lower level, but sometimes — when there are 35-40 mm weapons and not only CIWs for AA defence — engagements of surface targets is the prime task of the gun.

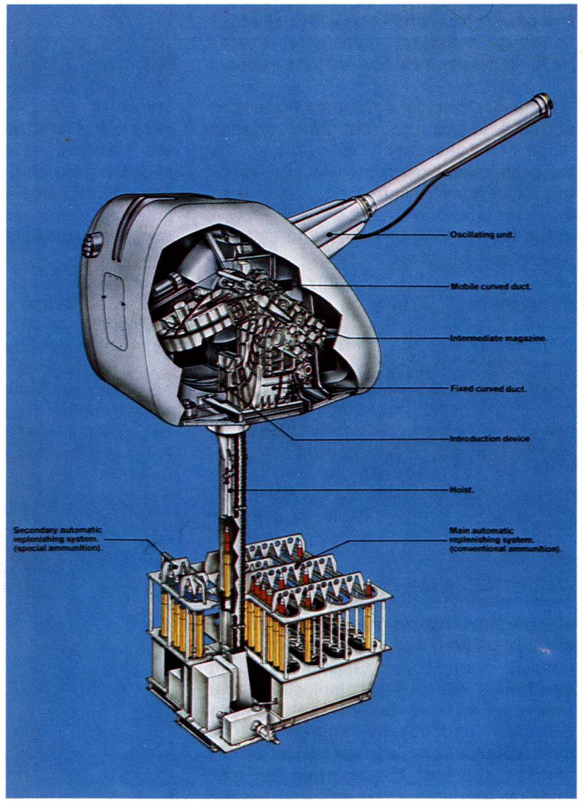
The governing parameter for a naval gun suitable for anti-ship engagement is 'of-course caliber, in relation to both lethality of the single round and to increased range. Accuracy and rate of fire are also important, but to a lesser extent than for AA fire, and more in order to make up for the presence of a single gun rather than to increase first hit capability. However, accuracy is also needed to reduce the expenditure of ammunition needed to achieve a kill — a sensitive point with the weight and space constraints resulting from the choice of a larger caliber gun.

A large caliber, long-range gun featuring a good accuracy and a reasonably high rate of fire is consequently the best choice when the anti-ship role has a more than passing importance. To all intents and purposes, and because of space and weight problems

Cutaway drawing of the FMC Mk45Mod1 127/54 mm gun.



Cutaway drawing of the Creusot-Loire 100/55 mm "Compact" gun.



Firing trials of the new Bofors 57/70 mm Mk II gun. The lack of the fiberglass turret shield allows for appreciation of the original automatic loading system, with two 20-round loading cassettes (the left one is not visible in this picture) which feed ammunition to the magazines mounted under them.

as well as for industrial considerations, in modern naval parlance this means a caliber of between 100 and 127 mm (nearly always a single turret, with only a few exceptions). The extent to which the choice of the caliber can be governed by industrial considerations can be guessed at by the limited commercial success of the Bofors 120/46 mm gun — at the time of its first appearance quite probably the best medium-caliber naval gun in the world, but hampered by the adoption of an ammunition which was only manufactured in Sweden.

The current Soviet trends as far as naval artillery is concerned are very interesting to analyse. After the not very successful 100 mm single turret (KRIVAK II, KIROV, UDALOY), the Soviet Fleet is now standardising the gun armament of all its new major surface combatants whith the new 130/70 mm twin turret, a weapon which, if the estimations made in the West are even approximately correct, outguns antything currently at sea in Western Navies (oh yes, the IOWA's 406 mm guns apart). It is still debatable and indeed is debated, whether this renewed Soviet interest towards larger caliber naval guns was triggered by new concepts about the importance of anti-ship/coastal bombardment fire or rather by the attempt to increase the range AA fire. The fact that the two guns are mounted on a single cradle very close to each other could simply be an attempt to keep weight and size down, but it also strongly suggests an attempt to minimize dispersion — a particularly important factor in burst AA fire. It is, perhaps, more than likely that all the above mentioned considerations played a role.

As modern naval vessels, with a very few exceptions, which are not likely to be engaged with guns, are not seriously armoured, the choice of ammunition for anti-ship fire is not a particularly difficult problem. In general, an HE round with delay fuze or a SAP (Semi-Armour Piercing) round will do the job; however, a fragmentation round with proximity fuze would probably be useful, when engaging at longer ranges highly-manoeuvrable and lightly built targets such as FACs and FPBs. Here again, terminally-guided rounds would (will?) represent a very important breakthrough.

Coastal bombardment role

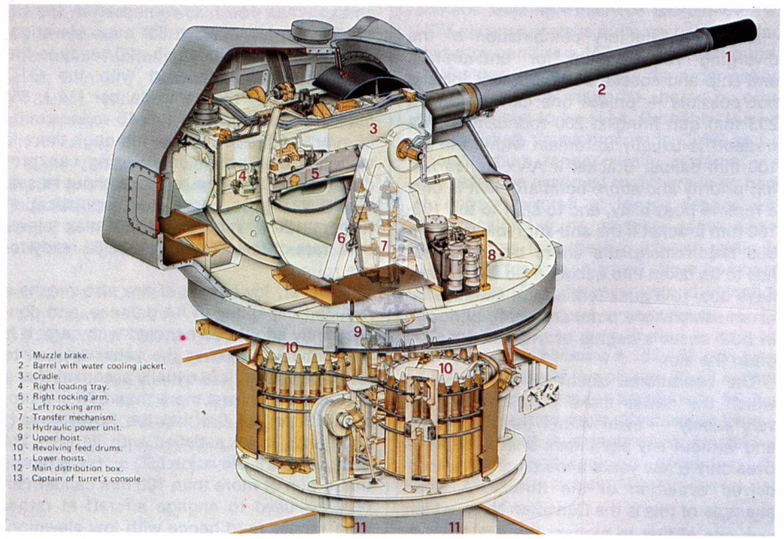
Although clearly expressed in the operational requirements of many navies, the need for naval artillery to engage shore targets has been a highly debated point in recent years. Many commentators, in fact, used to point out that the only navy with a truly serious need for fire support of landing operations was the US Navy; and it was only too easy to note that it makes little sense exposing a $200 million frigate in the highly dangerous waters a few miles offshore, for the sake of flattening some infantry trenches.

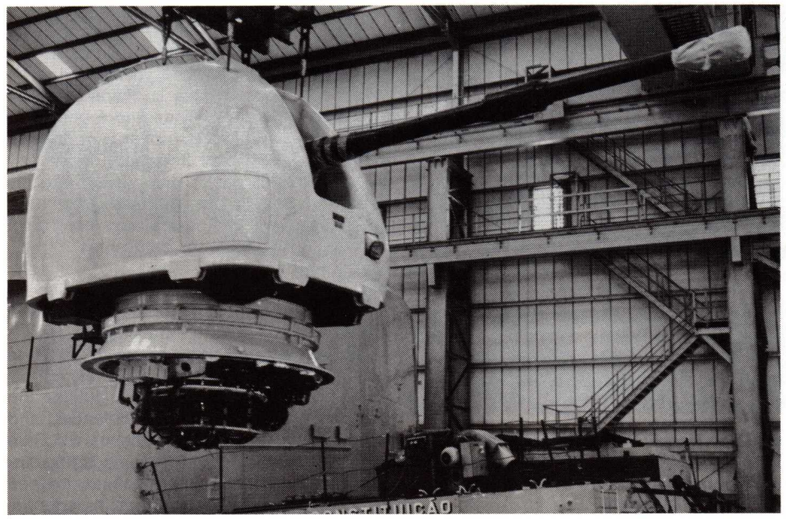
It can be guessed that after the Falklands the first point no longer holds true, and the second — although in itself indisputable — does not have any operational meaning. Indeed, if need be, a $200 million frigate has to be risked 3,000 m or so offshore, simply because there is no other means available to flatten those trenches. Or, better still a means does exist — in the shape of a carrier with her full load of attack aircraft; but as a first point there are unfortunately not very many carriers outside the US Navy, and as a second point naval gunfire support has many advantages when compared with shipborne aircraft. This is mainly because naval artillery can provide shore bombardment for longer uninterrupted periods, with a larger volume of fire and under any weather conditions. These are the reasons why the US Marines, although they have their own aviation, have always been suggesting "bring back the battleships".

For shore bombardment, caliber is the factor of paramount importance, to an even higher degree than for anti-ship fire. Here a long range is not only an useful asset to engage the enemy earlier, but a very critical factor if the ship is to remain outside the range of most of the shore defences; and highly lethal ammunition is mandatory. Rate of fire is only important when engaging elusive opportunity targets (such as massed troops or vehicles); much more important is the ability to deliver a high volume of fire, to be obtained not with rapid-fire bursts but rather with an uninterrupted and methodical pounding with large-caliber rounds. Given the size and weight constraints of nearly all modern naval vessels, the requirement for a large caliber is in direct contrast with the need for long actions, as the magazines could only accommodate a few rounds which would be quickly spent. Some commentators have consequently suggested that a smaller caliber gun be selected for shore bombardment, both because of the larger ammunition reserves which can be accommodated within a given space and because the same ammunition weight can be spread over a wider area: but in the light of the reduced range of a smaller caliber weapon (with the consequent higher risk for the ship which has to come closer to the shore, and the lack of capability to engage targets far inland) this suggestion appears to be rather disputable.

To all intents and purposes then, the current use of 100-130 mm guns for shore bombardment is far from being ideal, and only

Cutaway drawing of the OTO 127/54 mm gun. Notice the three independent ready-to-fire magazines, which allow to shift from one kind of ammunition to another under remote control.





The Vickers Mk8 114 mm gun, shown here being installed onboard the Brazilian frigate CONSTITUICAO (NITEROI-Class), is the standard medium-caliber gun onboard RN vessels. It was also exported to Argentina, Brazil, Thailand, Libya and Iran.

represents the result of considering coastal target engagement more or less as a "by-product" of anti-ship capabilities.

Naval vessels can fire ashore to engage soft targets (troops, massed vehicles, artillery and missile batteries, etc.) as well as hard targets (bunkers, fortifications, command posts, etc.); this second role is however to be considered with a certain suspicion, given the fact that such high-value targets are likely to be heavily defended. More often than not, the target will not be in visual sight of the ship, and the fire will be directed by a forward observer (on the ground or airborne); this makes no difference in engaging soft area targets, but requires a lot of ability and/or luck to destroy a hardened point target. And here again, terminally-guided ammunition will make the difference.

Two different types of ammunition could be used; an HE/fragmentation round with airburst proximity fuze for area targets, and an SAP round with impact/delay fuze for point hardened targets.

Combining the three

A fully satisfactory combination of the diverging requirements for anti-aircraft, anti-ship and coastal bombardment roles is not possible — unless one can develop a 203 mm gun firing at 200 rounds/min. The tradeoff is usually to remain within the 57-100 mm caliber bracket if AA defence has top priority and shore bombardment is only a remote possibility, and to shift to the 100-130 mm bracket if the anti-ship role is a serious requirement and shore bombardment has to be taken into account. So we actually have dual-role guns (either anti-air/anti-ship or anti-ship/shore bombardment), although in both cases a degree of trivalence is very often the aim.

The operational doctrines according to which the navies make their choices can vary widely — even within the same navy and without any significant shift in tasks — over only a few years according to the perceived evolution of the threats. A good example of this is the Canadian Navy, which was one of first to pioneer the use of modern larger caliber guns in frigate/destroyer size vessels (with the four IROQUOIS being the first warships to carry the OTO Melara 127/54 mm gun) and now is shifting to the opposite extreme by planning a 57 mm as main gun armament of its new 4,200 t frigates.

In addition to the characteristics already mentioned, other design parameters of a naval gun come into play when the attempt is made to design a truly multipurpose gun. For instance, a ready-to-use ammunition magazine allowing one to shift from one kind of ammunition to another with remote control and without human intervention is a very valuable asset, when the ship is engaging a target and a priority threat suddenly materialises which cannot be efficiently engaged with the ammunition being used (e.g. an air attack when firing against a surface target). However, this is difficult to obtain without increasing the dimensions of the system as a whole, or without reducing the number of reserve rounds which can be accommodated within the available space.

Accepting a lower rate of fire and lower elevation is of some help in keeping weight and volumes down, as witnessed by the US 127/54 mm Mk45 (25 t, 65° max. elevation, rate of fire 20 rounds/min., 20 ready-to-fire rounds) when compared with the OTO Melara gun of the same caliber (34 t, 85° max. elevation, rate of fire 45 rounds/min., 66 ready-to-fire rounds) — although there is evidence that better engineering can produce nearly the same results without losses, albeit at higher costs and sophistication (Bofors 120/46 mm: 28.5 t, 80° max. elevation, *rate of fire 80 rounds/min*, 52 ready-to-fire rounds).

However, lower rate of fire also means a reduced capability in AA defence, and consequently should be handled with care. It is still debated whether the same applies to lower elevation. It is usually assumed that a high elevation (say, more than 65°) is a prerequisite for AA fire, but the Royal Navy is apparently quite satisfied with its Mk8 114 mm gun (max. elevation 55°) on the grounds that a gun of more than 100 mm caliber can only be used to engage aircraft at rather long ranges (and hence with low elevation) and that there is no sense in firing with such a gun against an aircraft overhead.

Although a gun able to fire its ready-to-fire rounds automatically and in remote control is an absolute must, the importance given to gun manning requirements (for reloading and maintenance) varies from navy to navy. For instance, the Mk45 gun — now the standard US Navy gun for surface combatants above frigate size — is inferior in all respects to the older Mk42Mod9 it replaces (58 t, 85° max. elevation, rate of fire 40 rounds/min., 40 ready-to-fire rounds) but it weighs less than half, is far more reliable and easy to maintain, and requires a crew of only six men as opposed to 14.

Guided ammunition and the trend towards larger calibers

It is self-evident that the possible introduction of terminally-guided ammunition has a lot of appeal for many of the possible applications of naval artillery (although there also are shortcomings). However, the operational advantages would be of a different scale and scope than the true revolution expected from guided ammunition as far as land artillery is concerned. On land, terminally guided ammunition will be able to convert indirect fire weapons such as howitzers, gun/howitzers and artillery rockets, from area saturation weapons into precision weapons, giving them for the first time the ability to hit a single point target at maximum range. In naval gunfire, the only exception being shore bombardment, the target — no matter whether it is engaged with direct or indirect fire — is always in visual or electromagnetic sight; so that the aim was always to hit a point or a mobile target and not an "area". Hence, the advantages which can be expected from the introduction of guided ammunition are mainly linked to the increase in first round hit capability, with the minimisation, and correction, of the errors present in the original ballistic equation.

There is practically no limit to the different solutions which could theoretically be proposed for guided naval rounds; for instance, it has been pointed out that a full broadside of nine 406 mm rounds, fitted with auxiliary rocket propulsion for a range of 50,000+ m and arriving on the target at the same moment with terminal guidance, could easily defeat any anti-missile defence and sink nearly anything afloat. In practice, however, in the West there are two programmes currently active. In France, Thomson-Brandt is developing a 100 mm round with IR homing guidance, mainly intended for AA fire (but perhaps also suitable for anti-ship roles), while in the US Martin Marietta has been working for some years on a 127 mm derivative of the COPPERHEAD with semi-active laser guidance, and it appears that the US Navy should grant a contract in the near future. The Martin Marietta round is intended mainly for shore bombardment, and it can be used either with a separate laser target designator or with the new shipborne SEAFIRE optronic FCS which incorporates a laser range finder/target marker; it also could perhaps be used for anti-ship roles.

As a ship is in general not too difficult a target for properly directed naval gunfire (hits with the first three salvoes were not uncommon in WW2), it is understandable that attention is being focussed on anti-aircraft and shore bombardment fire. In the first case, the attempt is to dramatically increase the capability to hit the target(s) with a very few rounds fired; in the second, the aim is to allow precision support fire to destroy fixed point targets (bunkers, fortifications) or even mobile targets (tanks, SP artillery). It is also to be remembered that terminally guided rounds with passive guidance (such as IR homing) are much less dependent on the accuracy of the FCS than conventional rounds; consequently, they would allow a ship to deliver rather accurate fire even with her FC radars damaged or destroyed.

The prospectives are indeed exciting, as guided medium-caliber projectiles of any kind can roughly be assumed to have a hit probability of 70-80% at a range of 20,000 m, as against 5% for a conventional round. A certain philosophical resistance to the idea comes, however, from the fear that, if you give a projectile a sophisticated guidance package and, why not, rocket propulsion for increased range, then you have gone around the full circle and you are back to the missile — with all its advantages but also with its shortcomings that the gun (conceived as a relatively cheap, reliable and unsophisticated weapon system) was intended to correct.

Any significant breakthrough in terminally-guided ammunition for AA fire will in any case have a very important impact on the currently accepted tradeoffs between caliber and rate of fire. A really efficient guided round would sharply reduce the need for rates of fire approaching or exceeding 100 rounds/min., while the longer engagement ranges offered by larger caliber guns would become exceedingly important; moreover, it is, of course, easier to integrate a guidance package in a 100-127 mm round (while leaving sufficient space for the HE charge) rather than in a smaller shell. Consequently, development of AA guided rounds could well lead to a truly trivalent gun of between 100 and 130 mm, leaving the short-range AA defence to CIWS or to 35-57 mm weapons.

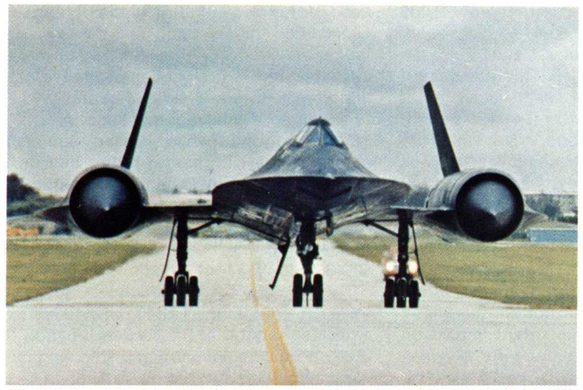
The US Navy, or at least some sectors of it (plus, of course, the USMC) has never felt quite comfortable with the performance of the 127 mm caliber for anti-ship engagement and for shore bombardment. A first attempt to introduce the 203 mm MCLWG (Major Caliber Lightweight Gun) was, however, abandoned, notwithstanding the quite interesting performance of the Mk71 203/55 mm mount; and efforts are at present concentrated on the new 155 mm Vertical Load Gun (see MT 1/82 page 111 for details), which FMC is currently proposing to the Navy. In both cases, the idea was to nearly abandon any attempt to design a gun suitable for AA defence in order to optimise it for anti-ship and coastal bombardment role; in the 155/50 mm VLG, the adoption of the very innovative vertical loading system, made possible by the acceptance of a reduced rate of fire (10 rounds/min.), has produced a mount ever lighter than the 127/54 mm Mk45 (22.5 t as against 25). The most interesting point about the VLG lies of course in the fact that it can fire the very wilde range of ammunition already available or being developed for army 155 mm towed or SP artillery, a range comprising HE, fragmentation, smoke, flare, RAP, submunitions, chemical nuclear, laser-guided (COPPER-HEAD) and mine projectiles, plus — in the near future — terminally-guided submunitions (SADARM, AIFS). This of course results in a far greater flexibility and versatility in engaging shore targets (and to a certain extent naval targets too); development of such a wide range of ammunition for the 127 mm gun is to be ruled out for reasons of cost. Also, in the US Navy's operational posture the availability of a nuclear round is an important asset: one should recall that the main reason why the Soviets are still keeping in service the old SVERDLOV-class cruisers is quite probably the fact that they can fire a 152 mm nuclear round.

Whether this trend towards larger caliber weapons will or would be shared by other navies, is still to be seen. Probably, the key lies in future developments in CIWS and in short/medium range missile systems: if it can safely be assumed that there is no need to engage aircraft at longer ranges with larger caliber guns, at least some navies could agree that these guns can again be optimised for anti-ship and shore bombardment roles. This, however, would somehow be in contrast with the other trends toward use of AA guided ammunition in 100-127 mm weapons, because a 152-155 mm naval gun with a rate of fire of, say, 20-30 rounds/min. (the minimum for an efficient AA fire, even with guided projectiles) would have — providing that it is technically feasible — dimensions and weights exceeding the limits of much current Western naval vessels.

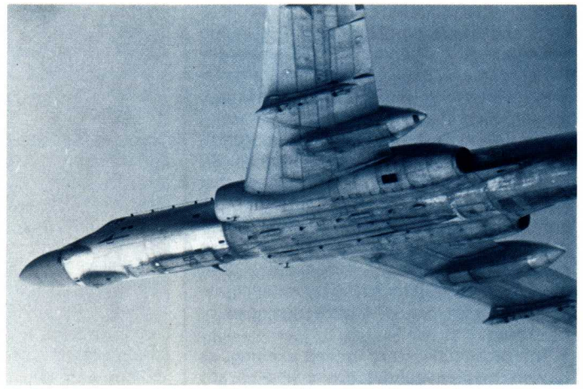
Modern medium-caliber (57-130 mm) naval guns in service in the world (*)

130 mm twin (USSR)	**USSR:** SOVREMENNY-class DDGs (2), follow-on UDALOY-class DDGs (2), follow-on KIROV-class CGNs (2), SLAVA-class CGs (1)
OTO 127 mm single (Italy)	**Canada:** 4 IROQUOIS-Class DDGs (1) **Italy:** 2 AUDACE-Class DDGs (2), 4 LUPO-class frigates (1), 8 MAESTRALE-Class frigates (1) **Peru:** 4 LUPO-class frigates (1) **Venezuela:** 6 LUPO-class frigates (1) **Iraq:** four LUPO-class frigates (1) **Nigeria:** 1 MEKO 360 frigate (1) **Argentina:** 4 MEKO 360 frigates (1)
FMC 127 mm Mk45 single (US)	**US:** 5 TARAWA-Class LHAs (3); 4 VIRGINIA-Class CGNs (2); 2 CALIFORNIA-Class CGNs (2); ? TICONDEROGA-Class CGs (2); 31 SPRUANCE-Class DDs (2); 4 KIDD-Class DDGs (2) **Turkey:** 4 MEKO 200 FFs (1)
Bofors 120 mm single (Sweden)	**Finland:** 2 TURUNMAA-Class corvettes (1); POHJANMAA-Class minelayer (1) **Indonesia:** 3 FATAHILLAH-Class FFS (1)
Vickers Mk8 114 mm single (UK)	**UK:** 12 SHEFFIELD-Class DDGs (1); 1 BRISTOL-Class DDG (1); 6 AMAZON-Class FFs (1); 4 BROADSWORD-Class FFs (1) (**) **Argentina:** 2 HERCULES-Class DDGs (1) **Thailand:** 1 MAKUT RAJAKUMARN-Class FF (1) **Brazil:** 6 NITEROI-Class FFs (2×2, 1×4); New Corvettes (1) **Libya:** 1 DAT ASSAWARI-Class FF (1) **Iran:** 4 SAAM-Class FFs (1) (***)
100 mm single (USSR)	**USSR:** KRIVAK II-Class FFs (2); 1 KIROV-Class CGN (2); 1 UDALOY-Class DDG (2)
Creusot-Loire 100 mm single "Compact" (France)	**Saudi Arabia:** 4 SAWARI-Class FFs (1) **Malaysia:** 2 FS1500 light FFs (1)
OTO Melara 76/62 mm (Italy)	Over 400 units of this gun have been ordered so far, and a complete listing would require too much space. It is presently in service with the following countries: Algeria, Argentina, Australia, Bahrain, Denmark, Ecuador, Egypt, Germany, Ghana, Greece, Iran, Iraq, Israel, Italy, Japan, Kuwait, Libya, Morocco, The Netherlands, Nigeria, Oman, Peru, Qatar, Saudi Arabia, South Africa, Spain, Taiwan, Thailand, Tunisia, Turkey, UK, USA, Venezuela. License production in Japan, Spain, US and perhaps Israel.
Bofors 57 mm (MkI and MkII) single	**Sweden:** 17 JAGAREN-Class FACs (1), 12 SPICA II-Class FACs (1), 6 SPICA I-Class FACs (1), 2+ STOCKHOLM-Class FACs (1), 1 CARLSKRONA-Class minelayer (2) **Norway:** 3 NORDKAPP-Class PVs (2) **Canada:** 6 "City" class FFS (1) **Singapore:** 6 SEA WOLF-Class FACs (1) **Thailand:** 3 PRABPARAPAK-Class FACs (1) **Malaysia:** 8 HANDALAN-Class FACs (1), 4 PERDANA-Class FACs (1), 6 JERONG-Class FACs (1) **Yugoslavia:** 6+ RADE KONCAR-Class FACs (1)

(*) Guns still in service, but no longer being manufactured and/or replaced by more advanced models from the same manufacturer, are not listed. Only vessels in service, being built or on order with a fixed set of weaponry have been considered; ships still being planned are not listed.
(**) Type 22 Batch 3.
(***) Two reportedly sunk in the Iran/Iraq war. Loss not confirmed.



An SR-71 BLACKBIRD taxiing for take-off. The BLACKBIRD is still the most important tool available to US intelligence for manned reconnaissance missions.



A Soviet Tu-16 BADGER-C reconnaissance aircraft intercepted during a probing mission north of the British Isles.

Tony Velocci

Strategic reconnaissance/surveillance

While satellites are only one method by which the US obtains intelligence information, great importance is attached to them as a source of strategic information for military planners. Another equally important source are manned aircraft which, almost by definition, are more versatile than unmanned satellites.
The information gathered by both satellites and manned aircraft for the US Strategic Air Command serves three purposes: it helps to define America's own military hardware requirements, it provides an insight to an adversary's strategy and it provides a basis on which the US and its allies can develop their own war plans.

While surveillance and reconnaissance are similar in purpose, the difference between them is important. The U.S. Joint Chiefs of Staff (JCS) differentiate between them in this way:

Reconnaissance is defined as a mission "undertaken to obtain, by visual observation or other detection methods, information about the activities and resources of an enemy or potential enemy; or to secure data concerning the meterological, hydrographic, or geographic characteristics of a particular area."

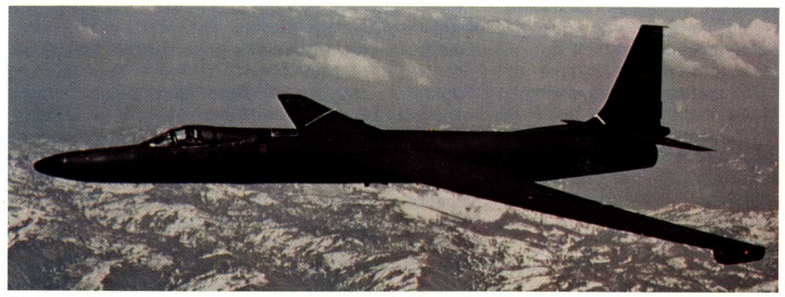
Surveillance is defined as "the systematic observation of the atmosphere, or subsurface areas, places, persons, or things by visual, aural, electronic, photographic, or other means." Further, surveillance systems collect information continuously, but reconnaissance missions are directed toward localized or specific targets — a job that can be performed by both satellites and manned aircraft.

The United States uses a variety of sensors deployed worldwide. And while the level of sophistication that the Soviets have achieved remains open to conjecture, experts generally believe that the U.S. probably has an edge in the field of strategic intelligence-gathering. For example, Moscow has no manned strategic reconnaissance aircraft that even comes close to the capabilities of the American SR-71 BLACKBIRD. But there is at least one exception to this claim of so-called superiority; the Soviet Union has two real-time ocean surveillance satellites in low earth orbit; the U.S. has no comparable capability.

The reason that the U.S. does have an overall edge, is due to the Defense Department's ability to handle large volumes of data, process it rapidly, and make information available to the President and military commanders worldwide. Reconnaissance information is made available to the Department of Defense, National Command Authorities and to allies of the U.S. It is processed and stored in computers located in the Strategic Air Command's underground command post complex at Offutt Air Force Base (Nebraska) and used by the Joint Strategic Target Planning Staff in the formulation of target lists and the Single Integrated Operational Plan.

There are two primary technical means by which strategic reconnaissance/surveillance is carried out: signal intelligence and imagery. The latter is generally considered to be the most desirable. Infrared film, radar, non-imaging infrared sensors, and forward-looking infrared sensors are all employed. The greatest advantage of film-based techniques used today is the detail that is available for locating, identifying, and determining the size of an enemy's force. The main drawback is the time required to deliver, process, and interpret the film after the target has been acquired.

The heart of America's strategic reconnaissance/intelligence network are spacecraft, most of which are in low earth orbit. At least one American spy satellite, or ferret, makes several passes a day over the Soviet Union, monitoring radio and radar transmissions and photographing selected targets, and it must be assumed that Russian satel-



Eight U-2R (the latest version of the U-2) are in front-line service with the US Strategic Air Command.
A spectacular side view of a BLACKBIRD. Although its basic design dates back to the late '50s, the SR-71 still looks very much "futuristic" today...

lites perform the same mission over American territory.

The U.S. TIROS I, whether it was planned as a space spy or not, inaugurated the use of reconnaissance satellites in 1960. Supposedly a weather-observation platform, TIROS I carried in its nose 9,200 tiny solar cells that were used to supply the power to transmit magnetic-taped photo images back to earth from its 450-miles-high orbit. The 270-pound satellite had two cameras: a wide-angle that utilized half a VI Vidicon tube and took a strip of overlapping photos at a resolution of about a mile and a half, covering an area about 135 miles long and 800 miles wide. A smaller, narrow-angle camera took pictures of a much smaller area. Also "blip" photos of runways and missiles were taken with an astonishing clarity.

The satellites that operate today share an important common trait; they all have a standard operating procedure, regardless of their mission or detection capabilities. As soon as a spy satellite passes over a designated programmed target, its cameras and electronic equipment are activated. On satellites employing radar imagery, signals can be digitized and the image relayed via a data link making it a virtual real-time sensor. Television can also transmit photographs back to U.S. ground stations instantly.

In the 1970s, both Soviet and American satellites ejected heat-resistant film cassettes to earth on command. Weighing between 200 and 300 pounds, the cassettes were equipped with small control rockets that controlled their re-entry. Upon entering the atmosphere, the valuable package released a heat shield, emitted a radio signal, and automatically dispersed aluminium chaff to facilitate radar tracking. Aircraft were directed to the drop area and snared the cassette, by now floating to earth beneath a parachute. If the recovery attempt failed, an explosive device destroyed the cassette preventing it from falling into the wrong hands. Some sources indicate that this recovery method is still employed today by the U.S., but Defense Department officials will neither confirm nor deny this.

According to one DOD source the U.S. has placed an estimated 200 classified intelligence gathering payloads into orbit. Most of these have been launched from Vandenberg Air Force Base, Calif., into a polar orbit. The reason for this is that as the world spins from west to east, satellites travelling north-south pass within sight of every spot on the earth at least once a day.

With the United States increasing its reliance on satellites for strategic reconnaissance/surveillance, is there a future role for manned systems? Experts say most definitely — for many reasons. One of the most basic is that the satellites now in orbit are becoming more vulnerable to attack. As most are in low earth orbit, they would be a prime target for the USSR's operational anti-satellite weapon system. Laser and particle beam weaponry, now under development and widely anticipated to be operational by the early 1990s, will pose yet another major threat. What's more, all military satellites depend on fixed ground stations for continued mission performance, and these ground stations are probably the most vulnerable portion of the system. In a recent assessment of satellite autonomy, America's space assets averaged out at level three on a scale of one to ten — zero being total ground dependence. Another consideration is that not all intelligence-gathering satellite networks can be easily reconstituted if parts of the network are damaged on destroyed. Space-borne reconnaissance/surveillance platforms also have certain technical limitations, especially photo reconnaissance systems. For example, cloudy weather, rain, and darkness severely restrict their usefulness.

All of this means that it is prudent to have a complementary, back-up strategic intelligence-gathering capability, and that is precisely what manned systems provide. "That situation is unlikely to ever change," says Donald C. Latham, deputy under secretary of defense for command, control, communications, and intelligence. "For some missions performed by manned aircraft, there simply is no substitute."

Besides providing this back-up, manned systems can also carry certain types of sensing equipment that isn't easily installed on spacecraft. Manned systems are much less predictable in where they will go and how they will get there, whereas satellites are restricted to fairly fixed orbits, and their ability to deviate relatively small. The fact that a crew is in control, over the reconnaissance target, makes the manned system inherently more flexible.

The United States relies on three aircraft for strategic intelligence-gathering: the SR-71 BLACKBIRD, the most advanced aircraft of its kind in the world, the U-2, and the RC-135, a variation of the commercial Boeing 707.

While the SR-71 has been in operation for nearly 20 years, and its basic design dates back to the late 1950s, senior Pentagon officials say that the BLACKBIRD "will be around for a long time to come." They add that when it is eventually retired there'll be another manned aircraft to take its place, although there is believed to be no successor on the drawing board at this time.

The Lockheed U-2, also known as the "Dragon Lady," made its first flight nearly 25 years ago. An estimated 55 were built and they were assigned to the Strategic Air Command's 9th Strategic Reconnaissance Wing at Beale Air Force Base in California with operating bases around the world.

Essentially a powered glider, the U-2 weighs only 13,000 Kgs and has a very high aspect ratio wing. This combination helps to provide an unequalled ability to loiter over an area for long periods of time in order to obtain detailed information. In fact, the U-2 was developed specifically for flights over the Soviet Union, although such flights officially ended in 1960 when a U-2 was shot down over Soviet territory.
The latest version of the U-2, the U-2R, is now the SACs primary version with eight in front line service. It is longer than the U-2 (63 ft) and has a greater wing span (103 ft); it is powered by a single Pratt and Whitney J75-P-13 turbojet engine with 17,000 pounds of thrust, which gives the aircraft a maximum speed of 430 mph at 60,000 ft and a range of some 3,000 miles. The operational ceiling of the U-2R is 90,000 ft plus.

SAC's RC-135, which first flew in the mid-1960s, have varying equipment configurations, depending on mission requirements. All are capable of detecting, intercepting, analyzing, and recording electronic transmissions. Inside, the flight station is forward, followed by the equipment area, operator area, and rest area. On-board systems include an ASD-1 electronic reconnaissance system, ALQ-70 ECM, ALA-6 direction finder, and APR-17 reconnaissance set.

With a crew of 16, including five relief personnel, the RC-135 can extend its 2,675-plus mile range with in-flight refuelling. Four Pratt & Whitney TF33-P-9 turbofan engines, each capable of producing 16,400 pounds continuous thrust, enables the RC-135 to cruise at 560 mph. Its top speed is 0.9 Mach, and its operating ceiling is above 40,000 feet.

There is one other aircraft in the world used for strategic intelligence-gathering missions on a routine basis: the Soviet Tu-95. Actually, it doubles as a strategic bomber and a reconnaissance/surveillance platform. First flown in 1954, the BEAR exists in a half dozen versions.

The most current, the BEAR-F, was first identified in 1973 and is regularly observed in flights over the U.S. Fleet at sea. In addition, American fighters frequently scramble to escort BEARs flying along the East Coast of the U.S. during transits between Murmansk and Cuba, and on electronic intelligence missions out of Cuba. An estimated 15 BEAR-Fs were in service in 1980.

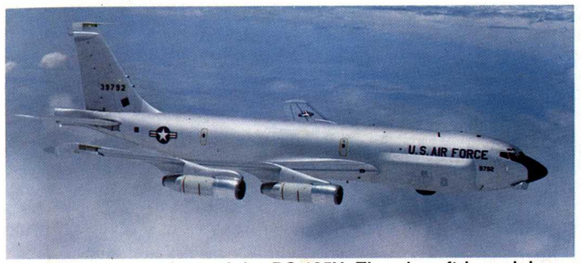
The BEAR-F, equipped with a tail gun, is more than 162 feet in length and has a wingspan of 167.8 feet. It has a cruise speed of 435 knots and maximum range of nearly 8,000 miles (with a 25,000-pound bomb load). Operational equipment includes a large X-band radar located in a blister fairing under the center fuselage and, according to SAC sources, photo reconnaissance gear.

In the U.S., there are at least two different directions in which strategic reconnaissance/surveillance is evolving simultaneously. First, an intensive effort is under way to improve the survivability of satellites. Defense officials are concerned with more than the possibility of a direct attack on the spacecraft itself; they are investing large sums of money into protecting the ground portion. Hardening, redundancy, satellite manoeuverability, and protection against laser attack are all being studied. Moreover, the Satellite Autonomy Program at the U.S. Air Force Space Division is working through the Autonomous Redundancy and Maintenance Management Subsystem. But this "solution", which interfaces only with the satellite telemetry and command subsystem, is only a short-term solution. Other, longer term initiatives are also under way.

The whole area of satellite survivability is in its infancy, and some military space hardware authorities claim the U.S. could improve the overall quality, including the survivability, of America's overhead assets by a factor of two by the end of this decade.

A second direction is in the field of advanced remotely-piloted vehicles. While they are usually associated with tactical battlefield reconnaissance/surveillance, some experts, including the Pentagon's Donald Latham, say they will eventually perform strategic missions as well.

The importance of strategic reconnaissance/surveillance is well-established and can only become more sophisticated in the future. As the U.S. Strategic Air Command puts it: "The mission's design for the future



Two different versions of the RC-135V. The aircraft is mainly used for electronic reconnaissance missions (ELINT) and for radiocommunications monitoring.

will be in the quest for improved vehicles that will ensure even greater accuracy and completeness of intelligence data." For the U.S. and its NATO allies, strategic intelligence-gathering is, in effect, the eyes and ears of the West's political and military leaders through which the necessary information is gained to influence and support national policy decisions.

John Chapman

New eyes for NATO

With the entry into service of the Lockheed TR-1, NATO has an aircraft which could play a key role in maintaining peace. Its ability to "see" far into Warsaw Pact territory should effectively eliminate the chances of a surprise attack upon the West. As the designation implies, the TR-1 is dedicated to Tactical Reconnaissance and although it has much in common with the U-2R — the latest version of the aircraft first flown nearly 30 years ago — it has quite a different role. It is another product of the Lockheed California "Skunk Works" which is responsible for the unique and remarkable U-2.

Over the years the weight of the U-2 has grown as more and more sensors have been added to enhance its strategic reconnaissance role. Despite the installation of a more powerful engine, the U-2 continued to be a difficult aircraft to fly, the added weight having decreased the already small margin between the stall and Mach buffet when operated at very high altitudes. The solution was to increase the wing area; indeed the U-2R is some forty per cent larger than the first U-2. The TR-1 is actually a version of the U-2R with interchangeable wings and other components. This is in order to ease maintenance and reduce costs.

Production of the first series of U-2 aircraft ended in 1968; but when the COMPASS COPE RPV programme was cancelled, it was decided to resume production of the secret reconnaissance aircraft. The opportunity was also taken to overcome some of the problems posed by increases in weight of the U-2. The TR-1 version would be required to carry several different types of sensor including some capable of detecting small targets at considerable distances. The first of a planned fleet of 35 TR-1s was delivered to the USAF in September 1981 and production is now well under way.

Of the total fleet, 18 are to be based at RAF Alconbury and four will be in service there by the end of this year. The full complement will be delivered to the Alconbury squadron by the end of 1986. It is planned that all but two of the USAF fleet will be single-seat TR-1As, the conversion of pilots on to type being carried out on a pair of two two-seat TR-1Bs. This training is carried out at Beale Air Force Base, California.

Although the performance of the TR-1 is an improvement over that of the U-2 and is easier to land, it is still an aircraft which calls for a high degree of pilot skill. Normally operated at altitudes in excess of 70,000 ft (21,000 m), the TR-1 is powered by a single Pratt & Whitney J75-P-13B turbojet engine which enables the aircraft to cruise at over 700 km/h. The TR-1 has a range of at least 4,800 km, permitting a considerable area to be surveyed during a patrol flight.

Unlike the U-2R which carries up to five 70 mm cameras, the TR-1A normally carries only a T-35 tracking camera, its main sensor being an advanced synthetic aperture radar system (ASARS) in the form of a side looking radar (SLAR). Designated AN/UPD-X, this system can provide real time data to a ground station where the information is processed and displayed. Both hard copy and a visual display on a CRT is possible in the data link station which can also be used to convert signals from the SLAR into terrain imagery.

Lockheed has designed the TR-1A to be equipped with interchangeable noses, mission bay hatches and wing pods; the aircraft can carry nearly two tons of sensors and other equipment. The SLAR has a range in excess of 300 nm enabling the TR-1 to "see" at least into Eastern Poland and probably beyond. On surveillance missions the TR-1 can cover 131,800 sq nm per hour, while other sensors will be used to locate radar and radio signals emitted from Warsaw Pact territory. A Precision Emitter Location System will enable a number of TR-1s to intercept signals transmitted from hostile areas and establish their source by means of triangulation.

The glider-like appearance of the TR-1A is clear in this head-on view.

SCIENCE/SCOPE

Vacuum-tube computers spanning half an acre of floor space will be replaced by modern computers the size of two vending machines when North America's new air defense system goes into operation this year. Hughes Aircraft Company's Joint Surveillance System will replace aging SAGE (Semi-Automatic Ground Environment) and BUIC (Back-Up Interceptor Control) systems. It will link U.S. Air Force surveillance radars, civil air traffic control radars, and Canadian radars into a shared system. Seven regional control centers -- each equipped with the smaller computers -- will monitor skies 200 miles beyond North American borders. An eighth center will monitor skies surrounding Hawaii.

To help tank gunners score a first-round hit, laser tank fire control systems instantly perform complex calculations involving nearly a dozen factors. The system determines the distance to a target based on the time it takes a laser burst to reach the target and reflect back. But before giving the gunner exact firing information, the fire control computer must process range data along with such major factors as target rate, tank cant (tilt), ammunition type, crosswind velocity, temperature, humidity, altitude, and gun wear. Hughes pioneered the "full-solution" computerized laser tank fire control system and now builds and licenses systems for most of the main battle tanks in the free world.

A GBU-15 glide weapon equipped with an imaging infrared seeker has been tested successfully by the U.S. Air Force. In a launch that simulated shooting into a tunnel, the weapon was released from an F-4 Phantom flying at 10,000 feet and 10 miles from the target. It met all test objectives by identifying, tracking, and hitting the target. The GBU-15 is a 2,000-pound guided weapon designed for use against high-value fixed targets. The new Hughes infrared seeker, which replaces the original TV seeker, allows the weapon to be used at night and in heavy haze.

A weapon-locating radar can pinpoint the sources of enemy artillery, rockets, or mortars -- often before the first projectile hits. The AN/TPQ-36 Firefinder radar sweeps a series of pencil-shaped radar beams, adjustable according to the terrain, along a 90-degree sector of the horizon several times a second. When an object breaks through this curtain, the system instantly transmits a verification beam. If this beam detects a target, the system's computer unleashes a rapid succession of tracking beams. While tracking this target, the radar continues scanning, locating other targets and developing tracks on them as well. Hughes builds the radar for the U.S. Army, Marine Corps, and selected allies.

Studies have begun to see how an advanced airborne surveillance radar might serve military forces late in this century. The radar would have a large phased-array antenna capable of generating many pencil-shaped beams and would complement the Airborne Warning and Control System (AWACS). One use of the new radar might be to listen in directions other than that of its transmitted beam. If it were to detect another active radar transmitter, the radar could turn its transmitter off (thus foiling an enemy's antiradiation missile) and do its surveillance by using the other radar's transmitted pulse. These concepts are being investigated by Hughes under several study contracts for the U.S. Air Force.

Although primarily tasked with information gathering the TR-1 will probably also be used to designate targets by means of the Joint Surveillance and Target Attack Radar (JSTARS) which is being developed for the USAF and US Army. This will provide target position and weapon cueing/guidance for ground or air-launched weapons.

As the TR-1 is required to fly close to a potentially hostile border, accurate navigation is essential. A comprehensive communication and navigation fit includes HF, VHF and UHF equipment, while Tacan, ILS and ADF is also fitted. An air data computer is carried to ensure that precise tracks are maintained.

Operating at near-space heights 13 miles up, the pilot of the TR-1 must wear a pressure suit and the cockpit is fitted with a food warmer and space-type food tubes.

The avionics and equipment is housed in a bay at the after end of the cockpit of the TR-1A and other mission equipment is housed in small bays in the rear fuselage and tailcone. Much of the equipment and sensors are carried in two large underwing pods 8.23 m long, each pod weighing 544 kg together with its payload.

On the training version of the TR-1, the avionics and equipment bay is displaced from behind the cockpit to make way for the instructor's position which is slightly raised above the front cockpit.

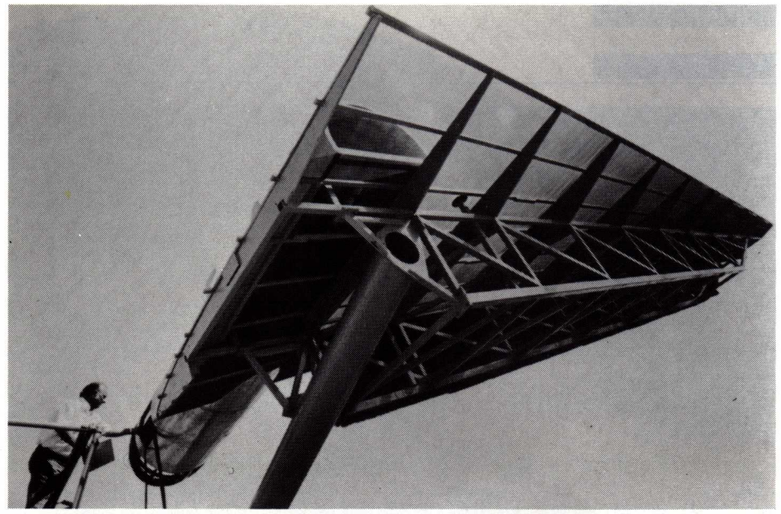
The U-2R/TR-1 is basically a simple design, the massive 31 metre wing span giving the aircraft a glider-like appearence. At 19 metres, the fuselage is relatively short, the underwing pods providing much of the space for stowing equipment.

Considerable effort has been made to eliminate all unnecessary weight, although composite materials have not been used to achieve this. Each aircraft is virtually hand built, the production rate varying between four and six aircraft a year. Great care is necessary to manipulate the very thin gauge aluminium alloy skin panels which cover the wings and the flying controls have been kept simple to obviate the need for frequent maintenance.

The flaps and spoilers are hydraulically controlled, while cables control the ailerons. Fortunately they require little maintenance for there are no inspection panels in the wing. Welding techniques are used to produce the wing and control surfaces. Much of the wing is used to carry fuel which is fed to the engine by pumps boosted by air pressure bled from the engine.

The spoilers are one of the modifications to the original U-2 design which were added to the TR-1 to aid the pilot. The aircraft is normally unwilling to settle on to the runway and the spoilers help to kill unwanted lift. Two air brakes on the side of the fuselage are also used as a landing aid but control is critical at this stage as the margin between the landing and stalling speeds is quite narrow. In fact retractable devices are fitted to part of the wing to allow a section to stall before the normal stalling speed is reached. Clearly the TR-1 calls for fine judgement on landing!

The bicycle landing gear is simple and lightweight but only the main wheels have brakes and are fitted with pneumatic tyres — all the other wheels having solid rubber tyres. Each wing tip is fitted with a skid and the outer wings are supported by jettisonable wheeled outriders used on take-off; these are replaced by the ground crew after the aircraft comes to rest at the end of its landing run.



A mockup of an inverted TR-1 wing is used at a Lockheed California research facility to study the reception patterns of the DME antennas that are part of the Precision Location Strike System. It is envisaged that PLSS-equipped TR-1s would help to locate enemy threats and direct strike aircraft toward appropriate targets.
The DME antennas are located in the wing pod being inspected in the photograph. Installed on the roof of the Company's antenna laboratory, the mockup is of the underside of a TR-1 wing and uses a copper screen to simulate the wing's aluminium skin. The wing is inverted to minimise interference from signals which might bounce off the ground ten metres below.

Two trainer versions of the TR-1 have been delivered to the USAF. Both are stationed at Beale Air Force Base and neither carries a mission equipment bay.

Much has been written of the deterrent value of nuclear weapons but there has been little mention of the deterrent which takes the form of sleek, black, unarmed aircraft which, in increasing numbers will be on sentinel duty for the NATO Alliance. They carry what are probably the most sophisticated electronic reconnaissance sensors and their systems can automatically transmit data on troop movements and armament installations back to earth.

The TR-1s will be able to provide a continuing assessment of the changing situation in Europe, and any build-up of Warsaw Pact forces prior to an attack would soon become evident. The ability to provide real-time reconnaissance information would enable Western commanders to react quickly to enemy movements.

Despite the fact that a large number of TR-1s will be based in England, the aircraft will remain under the jurisdiction of Strategic Air Command rather than United States Air Force Europe. This may well be to ensure that maximum flexibility in mission tasking is maintained as well as to make for a rapid response to command instructions.

West Germany is considered to be a potential customer for the TR-1; there is a known requirement for a new reconnaissance aircraft to patrol close to the country's Eastern border. Such an aircraft would have a major EW and ECM role.

Lockheed is anxious to keep the U-2R production line open after the delivery of the last aircraft to the USAF. It is indeed remarkable that an aircraft descended from a design originating in the mid-1950s should be a quiet but vital deterrent to Soviet military ambitions in the 1980s. Day or night and in all weathers, lone TR-1s will be maintaining surveillance over Soviet Bloc territory for many years to come.

The prototype of the SAPBA system (a FIAT truck carrying two sets of 9 tubes). This particular vehicle was lost when the ship that was carrying it to the Falklands (together with 70 launch tubes) was sunk by British Forces.

New defence developments in Argentina

Although in recent years — and at least till the Falklands/Malvinas conflict — Argentina had focussed its military re-equipment programmes on the so-called "Europa plan" (calling for acquisition or local manufacture of European-designed weapon systems), considerable attention was also paid to the development of indigenous design capabilities.

This latter point has had a dramatic increase in importance during and after the war and the consequent arms embargo, an embargo which, although it only lasted a few months — U.K. apart, of course — has abundantly shown to the Argentinians the risks of too strict a dependence on foreign sources of military equipment.

Consequently, all the indigenous programmes have been accelerated, and three of them are now entering service. These are a new assault rifle, a new artillery rocket system and a new AFV.

The FAA81 assault rifle

The origins of the FAA81 (Fusil de Asalto Argentino) date back to 1974, when the Argentinian Army launched a study to evaluate the feasibility of indigenous development of a new assault rifle for the '80s. The result of this investigation was the contract DGFM N° 1424, passed on May 4, 1976 to the Fábrica Militar de Armas Portátiles "Domingo Matheu". The aims of the programme were identified as follows:

— indigenous development of a modern assault rifle with characteristics and performance at least comparable with those of similar foreign weapons;
— steering of the development phase in such as way as to have the new rifle ready for mass production at the same time as the likely standardisation of 5.56 mm assault rifles in some different countries and alliances;
— obtain a quality product able to effectively compete on the export market.

The technical/operational requirements set up by the Argentinian Army were as follows: an ammunition with an energy of 0.360/0.500 kg/sec.; max. practical engagement range of no less than 400 m; 30-35 round magazine; fully automatic and semi-automatic fire; rate of fire of 650-750 rounds/min.; use of a bayonet; max. length of 850 mm (folded stock); empty weight of less than 4 kg; aiming system with two preset ranges (200 and 400 m); integral flash hider/muzzle brake/grenade launcher; grenade sight.

Additional requirements were the capability to be used by all the services, and by both right-handed and left-handed soldiers, without modifications.

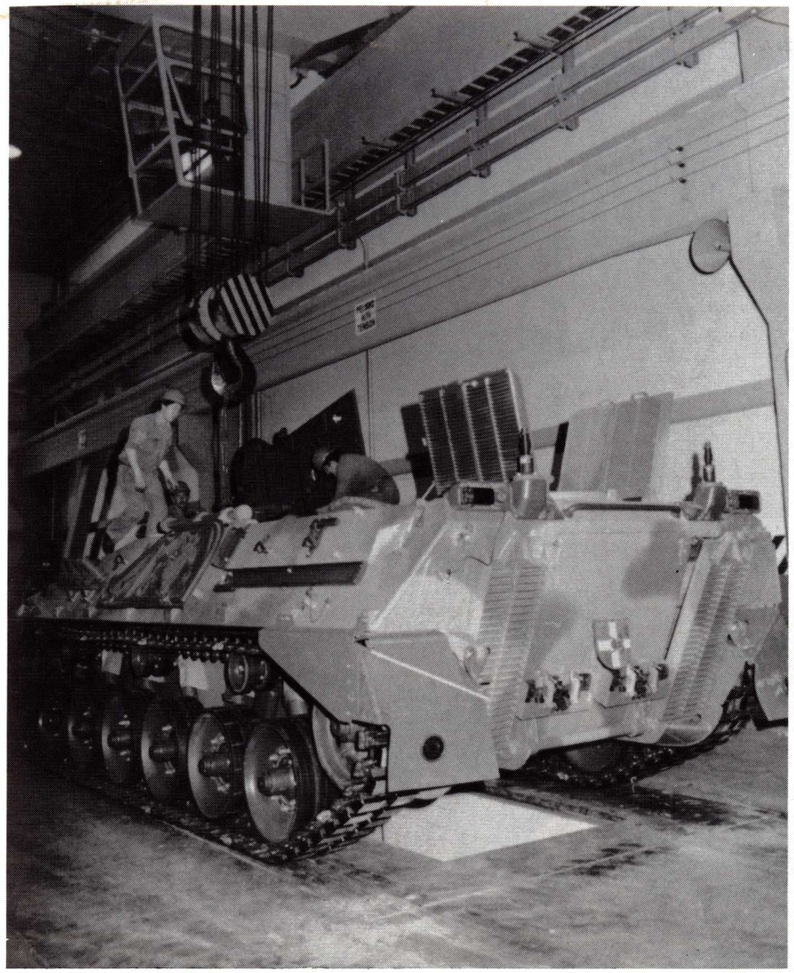
The resulting FAA81 is a 5.56 x 45 mm gas-operated weapon, featuring adjustable gas regulation device, and with the following main characteristics:

Length (max.)	980 mm
Length (folded stock)	730 mm
Height (with magazine)	260 mm
Width	70 mm
Total weight (loaded magazine)	4.260 kg
Loaded magazine	0.625 kg
Empty magazine	0.265 kg
Rifling	6 grooves, RH
Firing rate	710 rounds/min.

It is not known whether the FAA81 is rifled at a 7″ or at a 12″ pitch, but the first solution — allowing for optimal use of the SS109 ammunition — appears very likely. Locking is performed by a conventional rotary bolt with two lugs. The rifle uses at present a 30-round metal magazine interchangeable with the M16 magazines, but plastic magazines will be introduced in the near future.

The FAA81 has successfully completed the evaluation and acceptance trials with the Argentinian Army, and it is now ready to enter series production. In this context, it is interesting to note that during the Falklands/Malvinas war both the Argentine and the British forces used 5.56 mm assault rifles (M16 and AUG77, and M16, respec-

This article was already in print when we learned of the existence of a further variant of the TAM family, the VCPC (Vehículo de Combate/Puesto de Comando). The VCPC is the Command Post version of the basic VCTP; the 20 mm turret is replaced by a 7.62 mm MG, and the vehicle carries two VHF, an UHF and an HF communication set. Combat weight is 26 t; the VCPC carries six officers in addition to its crew. The communication equipment is of the German and Israeli origin.



Assembly line of the mortar-carrier VCTM. The vehicle is here receiving its engine.

ment, which adds a stabilising effect to the four folding fins. All the 36 rockets can be fired within 18 seconds, and it is possible to select either burst or single-rocket fire.

The system is mounted on a locally-assembled FIAT 697 6 x 6 truck.

The launch platform is stabilised by four hydraulic jacks; the tube complex can be aimed at 90° right or left of the vehicle, and from 0° to 60°, using hydraulic servos. A manual back-up system is available.

Firing is via a firing command box, connected to the launcher through a 50 m cable. This firing command box, which weighs 10 kg, is used to select the fire mode, to actually initiate firing and to send to the launcher the firing orders for each rocket at fixed intervals of 0.5 sec.

The SAPBA requires a crew of five: a commander, an aimer, two ammunition loaders and a further man to take care of platform levelling and connecting the command box. With this crew, the system can be put into and taken out of a battery in 2 min. and 1 min., respectively; reloading of all the four pods is performed in 5 min. Reloading can also be performed by a single man.

The Argentinian Army required the capability to saturate an area of 500 x 400 m at a 20,000 m range. This capability was demonstrated during the evaluation firing, carried on at the Serrezuela and Chamical firing ranges.

The rockets carry an 18 kg warhead. At present, two types of warheads are available: an HE/fragmentation warhead, which covers an area of about 1,000 m², and a proximity-fuzed anti-personnel warhead, which scatters its 4,500 steel balls over 6,000 m².

However, there are more than passing indications that Argentina has taken the extremely ambitious and challenging step of trying to develop an-anti tank rocket with IR terminal guidance. Whether this will be feasible or not still remains to be seen; in any case, it is to be mentioned that efforts in this sense are mainly aimed, not at the SAPBA, but rather at the future and much larger PAT-30 — more or less equivalent to the MLRS in size, caliber and performance.

A first pre-production SAPBA was sent to the Falklands/Malvinas during the war, but was lost at sea when the ship that was carrying it was sunk by British forces. On this occasion, some technicians of CITEFA — which should have assisted combat evaluation of the system — were also killed.

Delivery of series production SAPBA systems to the Argentinian Army started in May, this year.

tively). It appears, however, that both armies found that the good old FAL with 7.62 x 54 mm ammunition was still offering better performances: this both because the particular operational scenario put a premium on longer engagement range, and because the light 5.56 mm ammunition was affected by the very strong winds of the region.

The new Argentinian FAA81 assault rifle.

The SAPBA artillery rocket system

The SAPBA (Sistema de Proyectiles Balísticos Autopropulsados), which was developed by CITEFA, is an area saturation artillery rocket system based on a 36-tube launch element for 127 mm rockets, having a max. range of 20 km. The rockets, 2,228 mm long and weighing around 54 kg, are powered by a solid-propellant motor with a max. thrust of 3,500 kg; the propellant type PHE-2 was also developed by CITEFA.

The 36 launching tubes are subdivided into four pods with nine tubes each. This solution, combined with the crane fitted on the launching vehicle, allows for easy and quick reloading by replacement of the empty pods with new ones. The tubes are made of aluminium and are rifled in order to impart to the rockets a slow rotation move-

Test firing of the SAPBA artillery rocket system.

The VCTM mortar carrier

The VCTM (Vehículo de Combate Transporte de Mortero) is the first member of the TAM family developed in Argentina after the German-designed TAM (light tank) and VCTP (mechanized infantry combat vehicle). The programme was carried out by the Engineering Department of TAMSE, and required 30 months from prototype construction to series vehicles.

The main problem was represented by the high recoil forces developed by the 120 mm the VCTM was required to carry. After some attempts, the decision was taken to reinforce the vehicle's floor with a steel bar. The mortar is accommodated within a fighting compartment closed down by three hatches (one on the vehicle's roof and two on the sides) and can fire with the side hatches closed for better protection. The VCTM, which has a crew of five (commander, driver, two ammunition loaders, machine gunner) and is fitted with an NBC protection system.

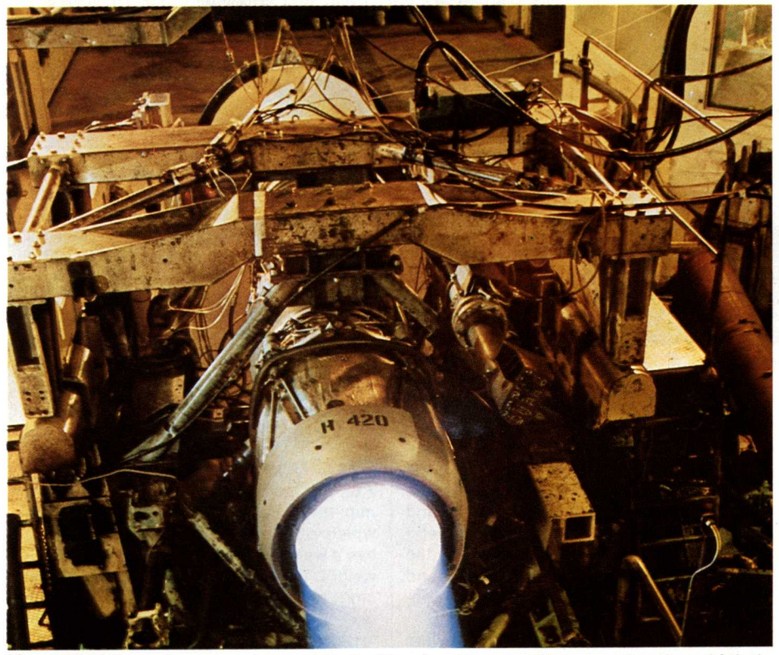
The weapon carried is the 120LR (Liviano Reforzado) 120 mm mortar, developed and built by Dirección General de Fabricaciones Militares. The barrel is 1.50 m long and weighs 44 kg; the cradle weighs 22.50 kg, the base plate 35.60 kg and the sight 1.3 kg. The mortar can be aimed throughout the full 360° and with an elevation from 40° to 80°.

The ammunition — 49 HE rounds and 12 PEPA/LA rounds — is carried on the left aft side. The 120LR mortar has a firing rate of 8-13 rounds/min., and max. range is 6,150 m with the M44/46 round (13 kg), 4,100 m with the GC round (17 kg), and 8,380 with the PEPA/LA round.

The VCTM is also equipped with a MAG 7.62 mm machine gun, mounted on a TPA mini-turret in the aft part of the vehicle and which can be fired from inside. The vehicle has a weight of 28 t in combat order (power/weight 26hp/t, ground pressure 0.72 kg/cm²), and dimensions of 6.79 x 3.25 x 1.858 m.

Deliveries of the VCTM to the operational units have already started, and series production continues.

MILTECH



The ARDOUR engine, seen here on test with reheat in operation, was developed jointly by Rolls Royce and Turboméca. The engine has since been manufactured under licence by Japan.

International co-operation in military aircraft engines

With weapons systems becoming increasingly more complex there is a trend towards collaborative projects between Western nations and this is increasingly being applied to military aero engines; indeed within Europe it is becoming a way of life out of sheer necessity.

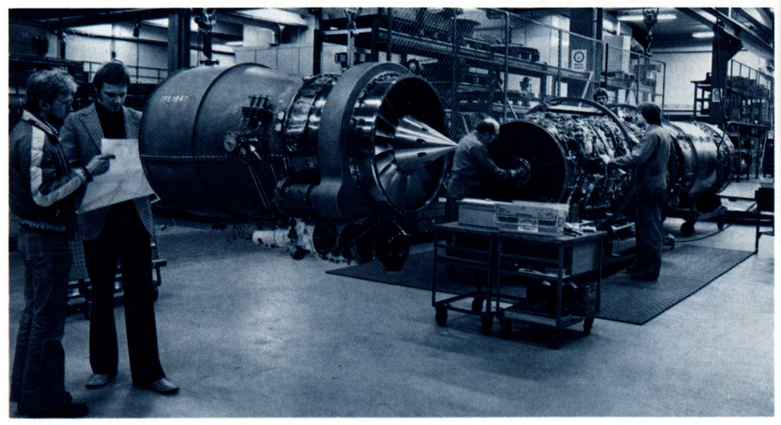
Collaborative or co-operative ventures are not new and may be broken down into three distinct types; licensed production, further development of an existing power plant and development of new aero engines which, unlike the former two, is normally a multi-national venture.

One of the world's most experienced manufacturers in collaborative ventures, and with experience of all three, is Rolls Royce Ltd.; indeed the company entered the business when faced with the prospect of a collaborative venture. When asked at the start of the First World War to manufacture Renault engines for the British Admiralty the company chairman, Henry Royce, baulked for he felt his company could produce a better one and consequently they began developing what became the Eagle.

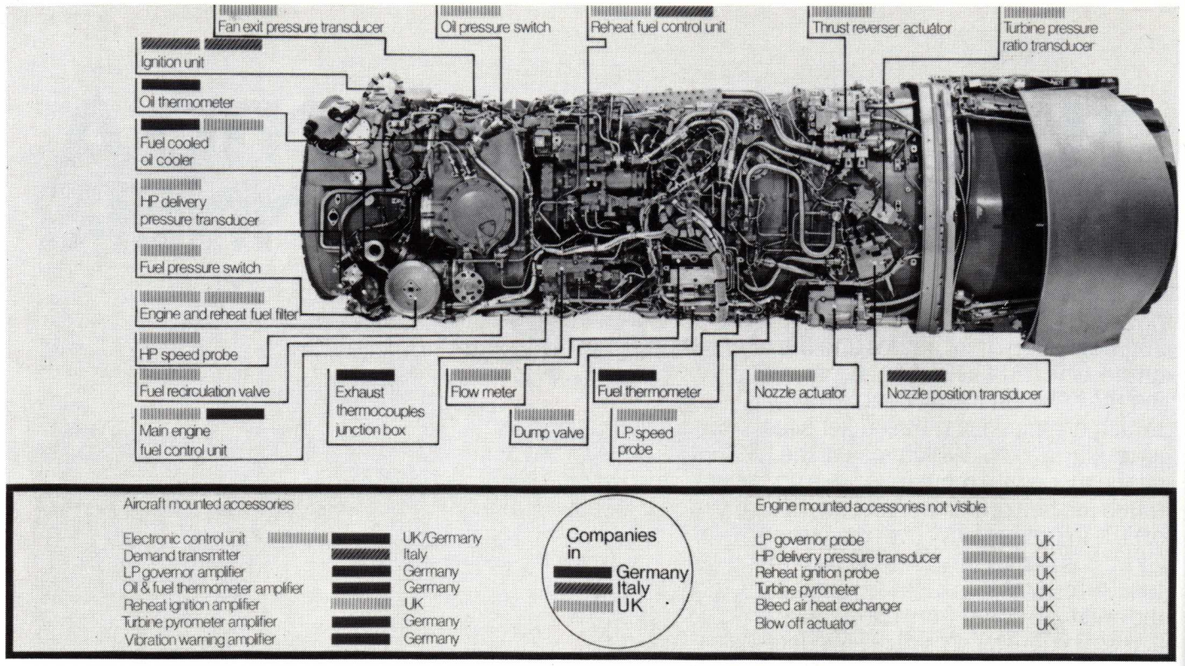
Licensed production was the only form of collaboration until the war years but the experience and technology transfer laid the foundation for several manufacturers although the basis of modern collaborative agreements did not emerge until the dawn of the Jet Age. During 1941 British expertise in such powerplants was given to the United States and incorporated in the General Electric GE-1A which powered the first American jet aircraft, the Bell XP-59A AIRACOMET while in the immediate post-war years the Rolls Royce TAY was developed by Pratt and Whitney as the J-48 and Hispano Suiza also developed the engine. These technological gifts were largely for political reasons, as was the presentation of the NENE to the Soviet Union in 1947, and not only had adverse strategic effects but also cost Rolls Royce millions of pounds in lost long term orders.

The excessive generosity of the first post war British Government has not been repeated and nowadays license agreements, in which the designer and licensee co-operate at the simplest level, are the most common form of collaborative agreement. It involves one manufacturer satisfying a clearly identified market with the product of another because economic, or technical, problems mean the potential licensee cannot meet the demands of that market. The designer, on the other hand, may also be unable to meet the market demand because it is uneconomic to do so or because he has no spare manufacturing capacity and a license agreement will bring revenue and often component work. For the licensee there is the opportunity to acquire technology and experience virtually without risk for a relatively low financial investment, the effectiveness of the agreement being based upon good management and organisation especially of the licensee. Rolls Royce currently has license agreements for military aero engines with manufacturers in the United States, Canada, France, Germany, Italy, Sweden, Finland, Rumania, Yugoslavia, India, China, Japan and Australia and most major manufacturers have a similar network of agreements stretching across the world.

It was through licence agreements that most European manufacturers acquired experience of powerplants for supersonic aircraft. In 1952 General Electric began development of the United States' first high compression variable-stator turbojet, the J 79, which was chosen to power the Lockheed F-104 STARFIGHTER and when this aircraft was chosen by most NATO air forces it was only natural that many nations should also produce the powerplant as well. Consequently the J 79-GE-11A was built by Fabrique Nationale Herstal in Belgium, Fiat Aviazione in Italy and the forerunners of



TFE 1042 engines, developed by Volvo Flygmotor and the Garret Turbine Engine Company from the Garret TFE 731, shown here in the Volvo Flygmotor overhaul shop. Three versions of this engine are envisaged and they will be used in the next generation of lightweight combat and training aircraft.



The Turbo-Union RB 199 represents by far the single largest and most important co-operation programme ever launched for development of a military aero engine. The picture shows the worksplitting between the British, German and Italian companies.

Motoren-und Turbinen- Union (MTU) in West Germany. The production of the J 79 also illustrates another aspect of licensing agreements, the strategic factor in which nations buy into an aspect of technology which they regard as of great importance, or even vital, to their strategic or commercial interests. Japan, for example, has always desired a considerable degree of self sufficiency but her armed forces have only a limited portion of national resources making it impossible for the aerospace industry to finance expensive military aero-engine projects even if they could export them. Consequently most powerplants are licence-built with Ishikawajima-Harima Heavy Industries, for example, producing the J 79 for the F-104J in the 1960s and later manufacturing the General Electric T 58 free turbine turbo-shaft for helicopter use and the General Electric T 64 gas turbine for the PS-1 and P-2J while its current work programme includes the Rolls Royce/Turboméca ADOUR (as the TF 40) for the Mitsubishi T-2/F-1 series, the Pratt and Whitney F 100 for the F-15 and the Allison T 56 for the P-3C. Similarly China, in 1975, signed a preliminary licence agreement for a version of the Rolls Royce Military SPEY 202/203 turbofan which is presumably to form the basis of the powerplants for China's next generation of military aircraft.

Such is the complexity of modern military aero-engines, however, that smaller manufacturers find it more difficult to make the capital investment needed to produce the complete engine. F.N., for example, are closely involved in the European successor to the F-104, the General Dynamics F-16 FIGHTING FALCON, but they do not produce the complete Pratt and Whitney F 100-PW-200 but rather the fan core engine modules for European, and third nation customers, as well as the United States Air Force, the company also assembling and testing engines for the European and third nation customers with deliveries to the F-16 producers beginning in September, 1978. Several of the smaller manufacturers are involved in supplying components for military powerplants to major manufacturers in the same way as FN while others are not content merely to copy an engine but frequently develop it is as well. Volvo Flygmotor, for example, provide components to Rolls Royce, MTU and General Electric and have been adapting engines to meet Swedish Air Force requirements for some considerable time, initially using British-designed powerplants, developing a particular capability in afterburners. They are currently producing the RM 8 for the Saab-Scania VIGGEN combat aircraft having used research and development data provided by Pratt and Whitney to adapt that company's JT 8D turbofan, which was developed for the civil airline market. Volvo replaced the two stage fan and four stage low pressure unit of the JT 8D with a three stage fan combined with a three stage low pressure to produce the 115.6 kN RM 8A used in the AJ-37 and Sk-37 while later the gas generator combustion system and the high pressure turbine unit were redesigned to increase thrust to 125 kN, the resultant RM 8B being used in JA-37 interceptor. Volvo have gained a great deal of experience in the design and development of both engines and afterburners which will be incorporated in the adaptation of another proven power plant for the JAS 39 GRIPEN, the Swedish Air Force's combat aircraft for the 1990s. They have chosen the General Electric F 404J 80 kN low by-pass augmented turbofan for its availability and low cost profile but it too will be modified to meet the nation's operational and flight safety requirements. Development of the Swedish F 404 will be made together with General Electric with Volvo handling about half the work in contract value terms and 40 per cent of the engine will be produced at Trollhatten while economical production volume will be attained by manufacturing components for supply to General Electric for its F 404s. Final assembly, inspection and testing of the Swedish engines will be Volvo's responsibility and they will also provide technical support and spare parts for the Swedish Air Force.

A major problem with either licence or development agreements, however, is that the partner is subject to the foreign policy of the designer government when it comes to marketing the engine to a third party, especially advanced military aero-engines. Hopes of selling the VIGGEN to India, for example, were dashed when the United States State Department reportedly refused to permit Pratt and Whitney to supply key components for RM 8s which would have powered Indian VIGGENs. For less powerful engines, however, there seem to be fewer restrictions. Yugoslavia and Rumania licence-build the Rolls Royce VIPER Mk 632-41R and 633-47 turbojet in their jointly developed SOKO-CNIAR ORAO/IRA-93 ground attack aircraft, the latter being used in the B model with licence-built afterburner. It is also interesting to note that, despite the U.N. arms embargo on South Africa, the Atlas Aircraft Corporation manufactures the VIPER 540 for use in the IMPALA attack aircraft by means of a sub licence from Industrie Aeronautiche e Meccaniche Rinaldo Piaggio.

The VIPER single-shaft axial turbojet also illustrates yet another facet of collaboration in which one company develops another's powerplant to improve the performance for specific aircraft. The VIPER is used extensively in trainer and light attack aircraft such as the Aermacchi MB 326 and Piaggio has built the VIPER 22-1 and Mk 540 under licence but in July 1969 Rolls Royce signed an agreement with Fiat for technical collaboration in the design, development and production of the VIPER 600 series with the Italian company responsible for the components behind the compressor, except for the turbine discs and blades. The latest ver-

sion is the VIPER MK 680, a modified version of the Mk 632 which made its first test flight in an Aermacchi MB 339 at Venegono, near Milan, in June. Full flight testing of the engine, which is aimed at the advanced trainer and light close air support aircraft market, was scheduled to begin at Bristol in September and it is planned to have the engine available for service next year. It is aimed to achieve a 14.5 per cent increase in thrust over the 17.8 kN Mk 632 through increased mass flow by modifying the compression system and increasing rotational speed 2 per cent, this increased power being achieved without increasing fuel consumption. Another Anglo-Italian development is the unaugmented, 49 kN Rolls Royce Military SPEY Mk 807 based upon the Military SPEY Mk 101 and the Civil SPEY Mk 555 which has been chosen to power the AMX close support aircraft which is being developed and produced by Italian and Brazilian companies. The SPEY Mk 807 first ran in June 1980 completing its type test in October, 1982 development being undertaken by Rolls Royce in association with Alfa Romeo and Piaggio who will, under Italian government plans, manufacture a major portion of the engine under licence.

Although there are numerous licence-build and development agreements to meet the needs of European and world wide markets there are relatively few involving the United States military market whose needs are largely met by domestic manufacturers, including several of the world giants such as General Electric and Pratt and Whitney, who are reluctant to see foreign penetration of this market and tend to react vigorously if such penetration seems forthcoming. Only when they are unable to meet a domestic need with a domestic product do American aero-engine manufacturers seek a foreign product, one of the exceptions being the Detroit Diesel Allison Division which has been co-operating since 1958 with Rolls Royce on jet engines for both military and civil use. In 1966 the partners were awarded a joint contract by the United States Air Force Systems Command to develop and produce an advanced version of the RB 168-25 Military SPEY turbofan to power the Vought A-7D CORSAIR II. Development and production began of what became the 64.5 kN TF 41-A-1, Rolls Royce providing parts common with the Military SPEY while Allison produced components specifically for the TF 41 as well as assembling and testing the engines. The first run was in October, 1967 and the following year the United States Navy ordered an uprated version, the 66.7 kN TF 41-A-2 for the A-7E, some 1,300 engines of both models being produced. When the U.S. Marine Corps selected the British Aerospace HARRIER V/STOL combat aircraft as the AV-8A, Rolls Royce signed a joint development agreement with Pratt and Whitney by which the American company could build 25 per cent by value of the parts for PEGASUS engines to meet United States orders. An improved PEGASUS, the 97.86 kN PEGASUS 11-21 (U.S. designation F 402-RR-406), is being developed for the AV-8B and includes a new shrouded LP turbine, this forming the basis for the production model the 96.53 kN F 402-RR-404A. Work is also under way on a power plant for an advanced AV-8B, the PEGASUS 11F-35 featuring an improved LP compressor to increase mass flow. A test engine ran in August, 1981 and the objective is to produce an engine with 103 kN thrust.

While the development of existing engines has become an established practice there has been a growing movement since the 1960s to develop advanced military aero engines in collaboration from scratch. The cost of developing new engines is rising rapidly; a powerplant for a trainer-light attack aircraft can mean an investment of some $300 million while for a sophisticated combat aircraft the investment could be anything from $1½-2 billion and the market for such power plants is inevitably limited. Consequently manufacturers are reluctant to take the financial risk entirely on their own shoulders and seek to spread the burden while the absolute necessity for an end customer increasingly means a multi-national development for, apart from the super powers, few countries are prepared to undertake the manufacture of a new, sophisticated combat aircraft themselves. Not only do collaborative ventures spread the financial risk but they also reduce it for there becomes a political incentive to continue the project and provide the market. Politically there are benefits for all the participants in the shape of technology exchange and improved long term job prospects, especially for skilled workers, while the manufacturing partners can capitalise on their individual expertise and produce economies of scale, although these may be slightly offset by the need to assemble the powerplant at several centres.

The most serious potential drawback is the delays which may ensue from the need to provide a consensus on the powerplant specifications, there could be minor drawbacks if an element of duplication appears in the production process.

Project management is obviously vital both to overcome technical problems and the inevitable corporate or personal friction which may be encountered and the most effective way appears to be the creation of a small, simple, corporate structure with ultimate responsibility for development. Detailed planning is vital and there must be plenty of leeway to allow for technical problems, a typical development programme lasting up to 10 years; Turbo-Union, for example, was formed in October 1969, their first RB 199 ran two years later with flight testing beginning in April, 1973 while the first deliveries were in May, 1978. The partners must also set high technical targets which will involve a degree of new technology with all the risks that involves while another major problem is long term forecasting of the market. All these problems can place a strain on relations between the partners especially with the inevitable difference in views likely to be encountered while their agreement may also be effected by financial, technical or production problems of an individual company and there is always the prospect of political capriciousness.

It is a tribute to the aero-engine industry's determination to succeed, a spirit reinforced by awareness of the consequences of failure, that no purely military aero-engine collaborative agreement has collapsed despite the tremendous pressures. A good example is the collaboration between Rolls Royce and French manufacturers who are famous for their competitive spirit. It began with development of the OLYMPUS 593 for CONCORDE but soon turned to military applications with the need to meet a short term RAF-Armee de l'Air requirement for a simple, rugged engine. To meet this need Rolls Royce and Turboméca created a joint company, Rolls Royce Turboméca, to develop the engine, the ADOUR, and enter into commercial contracts for its sale to third nations as well as granting licences. Development responsibility was split simply with Turboméca responsible for the "cold" end and Rolls Royce for the "hot" end using proven technology, SNECMA producing an afterburner under a sub contract from Turboméca. Although no specific demonstrator existed the simple management structure ensured the programme was completed within the financial estimates and time frame, bench testing beginning in May, 1967 and by 1972 it was available for the SEPECAT JAGUAR and the British Aerospace HAWK, assembly from single source manufactured parts taking place at Rolls Royce's Derby plant and Turboméca's Tarnos factory. Another advantage of collaborative agreements is that many nations have a special relationship with certain other countries, as do companies, and this may be exploited to assist marketing. It was the long established link between Rolls and the Japanese aerospace industry which helped acquire a licensing agreement in 1970 with Ishikawajima-Harima Heavy Industries to produce the 32.5 kN ADOUR MK 801A, as the TF40-IHI-801A, for the Mitsubishi T-2 trainer and F-1 combat aircraft. The partners have continued to develop the engine, the latest model being the non augmented Mk 861, rated at 25.4 kN, while further developments are likely if British Aerospace decided to proceed with the HAWK 200.

So successful has the partnership been that Rolls Royce Turboméca are currently developing the RTM 322 turboshaft based on a core derived from the RTM 321 technology base. The objective is to produce a range of engines in the 1342 to 2237 kW class for helicopter, turboprop and turbofan applications. The core is sized to cover initial ratings of 1342 kW and 1566 kW with a growth potential of more than 2237 kW combining high performance with low costs. Hardware development has begun and it is hoped the first engine will appear within a couple of years and it is likely an Italian partner, possibly Piaggio, may join the development programme. The partners intend offering the RTM 322 as an alternative to the General Electric T.700 for helicopters in the 7-15 tonne class and it has been proposed as a powerplant for the EH 101 Anglo-Italian helicopter.

By far the most ambitious collaborative agreement is the production of the RB 199 for the Panavia TORNADO and with production at a rate of 20 a month its success, despite tremendous potential difficulties, must be regarded as a model to other manufacturers. The RB 199 evolved from a Request for Proposal by Panavia for a very advanced engine with low fuel consumption in the primary subsonic, low level strike role, and a very high boost with reheat for acceleration to high supersonic speed. Great importance was attached to the involvement of the engine industries of the Panavia partnership countries but the competition was open to European and United States companies. Before their amalgamation in 1966 both Rolls Royce and Bristol Siddley had been developing turbofans with characteristics appropriate to multi-role, variable wing aircraft, indeed Bristol and SNECMA had worked on a family of such engines based on a scaled down version of the OLYMPUS, including the M-45, although this had not proved a success. Meanwhile Rolls Royce, who had worked closely with MTU's forerunners, had agreed with them a joint advanced component programme which, incorporating Bristol's experience, formed the basis of the response to the RFP. The Anglo-German partnership was joined by Fiat Aviazione to create Turbo-Union in October, 1969, the original partners holding 80 per cent of the shares divided evenly and Fiat holding the remainder.

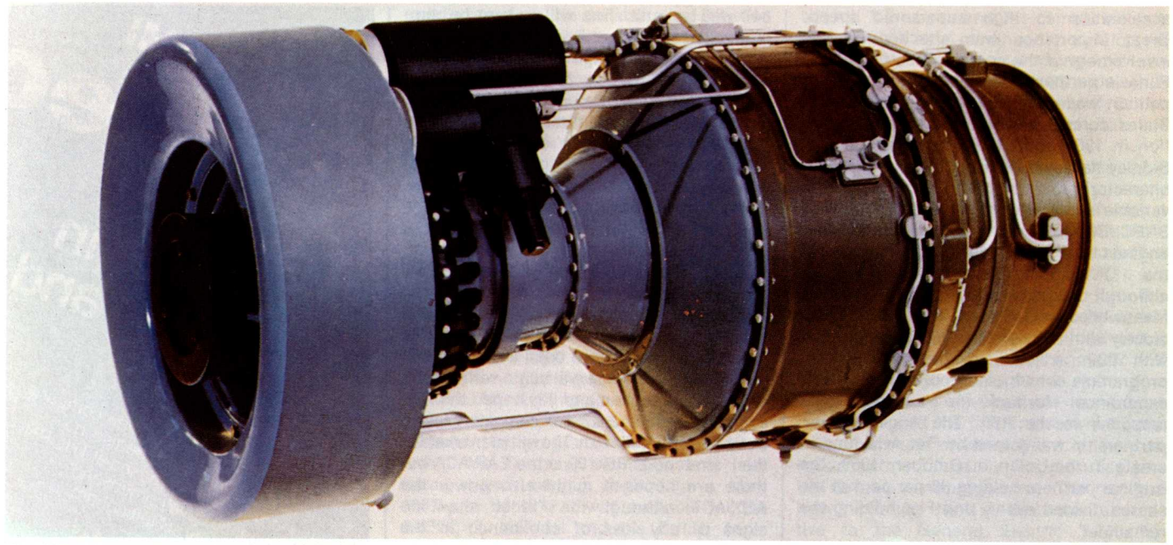
Turbo-Union acts as the engine subcontractor to NAMMA (NATO MRCA Management Agency) at Munich where it maintains a small liaison office of 25 key personnel, the project management office being at Bristol. Under the Turbo-Union board, which has representatives of each partner, and which oversees the programme and defines policy, are a series of functional working groups, 10 in number, dealing with such aspects as planning, manufacture, engineering, purchasing, test and reliability; each group consisting of a Turbo-Union representative and a representative from each partner. This corporate structure has helped develop common procedures and, by regular meetings, has ensured there have been no serious problems with interfaces as well as building up mutual confidence which has not only helped the smooth progression of the project but also the production process itself, for the partners are so confident of each other's quality control that components are checked only for transit or receipt damage before entering the assembly lines in Munich, Bristol, and Turin, these components and personnel being ferried by a one-plane "airline", a modified BAC 1-11 which runs scheduled flights between the main manufacturing centres.

Work has been shared by value roughly in proportion to the shareholding in Turbo-Union and has been greatly assisted by the decision to use a modular concept for improved maintenance and overhaul. Production of some 2,000 engines was planned with Rolls Royce responsible for the LP compressor, combustion chamber, HP turbine stator and HP turbine rotor, together with the turbine casing. MTU produce the IP compressor, intermediate casing, external gearbox, bypass duct, HP compressor, IP turbine stator and rotor while Fiat produce the LP turbine stator and rotor, as well as the exhaust diffuser, all the partners contributing to the exhaust system. Each nation assembles the engines for its own TORNADOs and by July, 1983 some 800 of the 2,016 engines had been delivered.

Development of the RB 199 continues and in May work on the second production version, the Mk 103 with 5 per cent more thrust than the 71.2 kN Mk 101, began to supplement the initial production version of which 847 will be built. This will in turn be supplemented in 1985 at Bristol by the Mk 104 with extended jet pipe and digital engine control unit, of which 325 will be built for the RAF's ADV (Air Defence Variant) to give 84 kN, a 20 per cent increase in thrust over the Mk 101. Turbo-Union is also continuing development work which, like national aero-engine manufacturers, it must finance from its own resources. The first part of the programme is Demonstrator Engine 1A (Demo 1A) with new LP compressor, increased capacity IP and HP compressors as well as improved combustion chamber. Testbed work began in December, 1982 and a 15 per cent thrust increase over the Mk 101 is reported to have been attained. Next year the second stage will begin with a modified turbine section and it is hoped the new engine will have a 22 per cent increase in thrust over the Mk 101. The initial market for this "stretched" RB 199 is the EAP/ACA but there are hopes it might also power the ACX/ACT, although the French show no signs of any loss of confidence in the SNECMA M 88. Rolls Royce are also working on an Advanced Core Military Engine demonstrator which is due to start testbed runs in 1985 and this may possibly form the basis of another Turbo-Union project.

A major disadvantage of advanced military powerplants is the difficulty of arranging licence or offset agreements with potential customers. Not only must all the partners' governments give security clearance but also the prospect of work going abroad can be politically sensitive, especially at election times. Moreover few nations have the skilled workforces or technical sophistication to produce complete engines even if they do possess both the management expertise and financial resources for capital investment in such programmes. Offset agreements are the best means of marketing but even here there are relatively few potential customers who can match the technical or commercial requirements, for example high production costs have even prevented one American manufacturer taking its share of components in one military aero-engine agreement.

The United States, however, is involved in some collaborative agreements which are associated with military markets but it is still in a relatively small way. It was mutual recognition during the late 1960s of the large market for high bypass ratio engines in the 10 tonne class with low operating costs and ease of maintenance which led to General Electric and SNECMA forming CFM International in 1974 to develop the French company's M-56 engine as the CFM 56. The parent companies own and staff CFM International on an even basis and have made it responsible for assigning design, development and production to the partners on the same basis, each partner then assuming responsibility, including funding, for the task throughout the programme life, a unique concept. The core of the CFM 56 is derived from General Electric's F 101 turbofan and SNECMA is responsible for other components, including the low pressure system and reversers, part of the low pressure system being built by FN on a sub contract basis. The first demonstrator ran in the United States in June 1974 and development flight testing began in March, 1977. Although the engine was intended for the civil market the 97.86 kN CFM 562B1 was

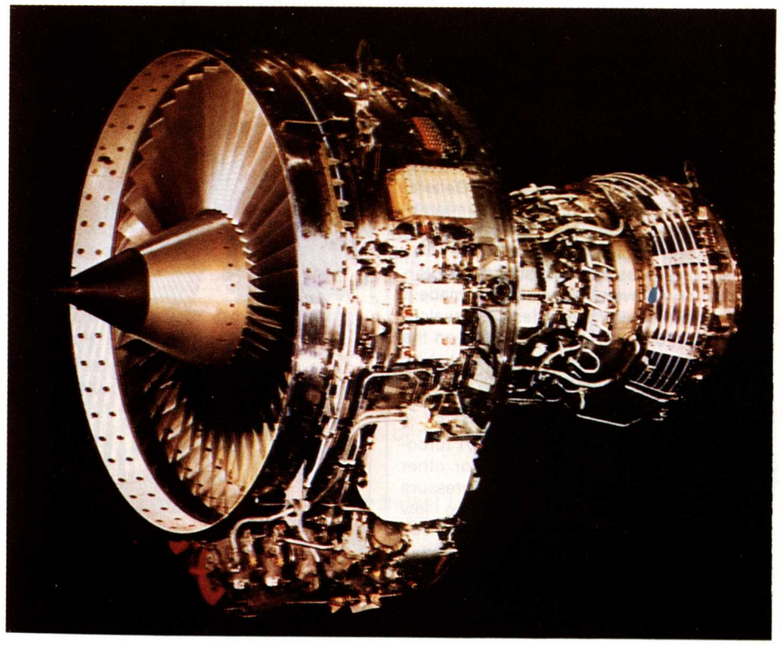


The MTM 385-1, derivative of the MTM 380 turboschaft, will be jointly produced by MTU and Turbomeca. This engine which develops 800 kw is at present envisaged as the power unit for the PAH-2 anti-tank helicopter.

chosen for the USAF's KC-135A tanker re-engining programme, the first flight of the KC-135R taking place in August, 1982 and some 30 KC-135As are scheduled to be re-engined. General Electric is also collaborating with Turboméca on a turbofan derivative of the TM 333 turboshaft, this project originally being intended for the USAF's NGT.

Nevertheless most collaborative military powerplant projects are focussed on Europe. The Garrett Turbine Engine Company and Volvo Flygmotor are currently developing the TFE 1042, a low bypass ratio development of the Garrett TFE 731, for use in the next generation of lightweight combat and training aircraft with three versions envisaged; TFE 1042-5 with 18.6 kN thrust, the TFE 1042-6 with 21.5 kN and an afterburner version of the latter, TFE 1042-7 which will have 31.1 kN. Garrett are responsible for the overall design and will manufacture all parts common to the two basic engine models while Volvo will carry out detail design and manufacture non-common parts such as the new two stage fan and afterburner. An unaugmented prototype, TFE 1042-4, began running on a test bench in August, 1979, 17 months after the two companies signed their agreement, and flight testing prototypes can be available within two years. A more long term project is the gradual evolution of the Rolls Royce PEGASUS into a powerplant for a supersonic STOVL combat aircraft for service in the late 1990s, for which the outline operational requirements are beginning to emerge. The Pratt and Whitney-Rolls Royce joint development programme agreement of 1980 also covers this aspect of PEGASUS development and currently Rolls Royce are carrying out a series of plenum chamber burning (PCB) trials with the object of augmenting thrust possibly by 50 per cent. This programme is being funded by the British Ministry of Defence as a purely national project and the contribution of the American company appears to be of a minor nature.

The CFM 56 has been produced by SNECMA and General Electric working together. The share of the work has been split on a 50-50 basis. The high by-pass engine has been chosen to re-engine the USAFs KC-135As.



Another powerplant which is intended for an, as yet, undeveloped airframe is the MTU-Turboméca SARL MTM 385-1 turboshaft. The partners have set up the new company to offer the 800 kW class MTM 385-1, a derivative of the MTU MTM 380, as the powerplant for the Franco-German second generation anti-armour helicopter and work will be split on a 50:50 basis by cost, with MTU responsible for the combustion chamber, gas generator and power turbine. The engine is still in the design stage, although some components including the gas generator, have been tested and a mock-up has been completed so that it seems extremely likely development will be largely completed by the time the two nations have agreed upon an airframe.

The interest that is being shown by the U.S., in the need for a NATO VTOL engine could lead to a co-operation agreement between the U.S. and Europe. The firms involved in negotiations at the present time are Pratt & Whitney, General Electric and the German firm of MTU. It is believed that Rolls Royce are not being considered for this project, which if pursued could be worth millions of dollars, because they are too involved with their own technology.

Economic pressures to collaborate on military aero-engine development is remorseless and seems likely to be irresistable within Europe during the next few decades, especially for the more sophisticated powerplants, and while at the lower end of the market it seems likely manufacturers will be able to continue independently commercial pressures may well persuade them too towards collaborative ventures.

Beechcraft MQM-107 Target System.

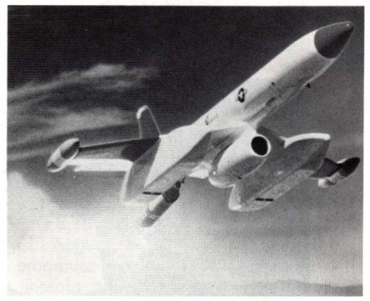
The ideal air defense target: Elusive enough to provide realistic training. Highly reusable, so you can afford to practice.

Air defense is a nation's first line of defense. Target practice is, and always has been, the key to air defense readiness. The Beech MQM-107 target system – realistic, versatile and affordable – offers the kind of training realism and training repetition that missile, gun and air crews need.

No other target can match it in cost-effective training for a combat-ready air defense.

The MQM-107 has the performance to carry a wide variety of target devices. Arrayed below:

1. *Pyrotechnic optical plume simulator (POPS)*
2. *Flare dispenser pod*
3. *Scorer pod*
4. *Foam cone radar reflector*
5. *Infrared augmenter boom*
6. *Flare/chaff dispenser*
7. *Bullet scorer/tow banner*
8. *Bistatic radar reflective pod*
9. *Radar tow target*
10. *Infrared tow target*
11. *Infrared tip pod*



MQM-107 drone with chaff dispensers is rocket-boosted from mobile launcher.

The recoverable MQM-107 can simulate aircraft attacking at high subsonic speeds, at low levels or altitudes to 13,000 m. A booster rocket gives the drone zero-length launch, and an 830-lb. thrust turbojet engine delivers sustained performance, even with payloads as heavy as 45 kg internally, or 160 kg externally.

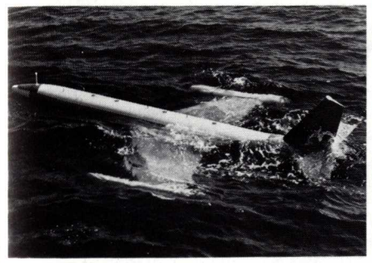
This payload capability is the key to MQM-107 versatility: A variety of target devices, especially towed subtargets, enable it to perform multiple target roles without complex, costly modifications. MQM-107 payloads include:

- Radar, infrared or visually augmented tow targets
- Gunnery tow banners
- Active and passive radar augmentors
- Infrared augmentation pods
- Scoring devices
- Radar and infrared countermeasures and more

Multimission target adaptability allows training with various air defense weapons: radar-guided missiles, heat-seeking missiles, or guns (air-to-air or surface-to-air.)

1.
94% reliability; 25 mission life.
Ruggedness, reliability and maintenance simplicity are inherent to the MQM-107 system. The proof: a mission reliability overall of 94%, an average drone life of 25 missions.

The more target presentations per launch, the more cost-effective the training. Here again, the MQM-107 is unsurpassed with an average of four target presentations for missile weapons, and as many as 30 presentations for air defense guns.



Buoyant MQM-107 is recovered at sea following an air defense exercise.

It all adds up to lower total training costs; to more, cost-effective training; to improved air defense readiness.

2.
Acquisition, track, fire!
A training exercise begins with the MQM-107 drone being taken to its launch site and positioned on its launcher. The weapons crew gets ready.

The target drone is launched; controlled to fly at speeds to 525 kts, altitudes as high as 13,000 m or as low as tree-top level. Evasive maneuvers and countermeasures can make things even more difficult for the weapons crew.

A "lock" on the target is obtained: The target is identified, tracked; the weapon is fired.

A "hit" (or a miss) is recorded. Another try? The versatile MQM-107 can be brought back for a repeat performance. Mission completed: The parachute recovery system is deployed and the drone descends safely to earth. The recovery crew is on its way to pick up the drone and prepare it for another mission.

Parachute brings MQM-107 down gently for re-use.

3.
Recovery at sea.
Naval forces need air defense readiness, too. The MQM-107 can be used to train shipboard weapons crews.

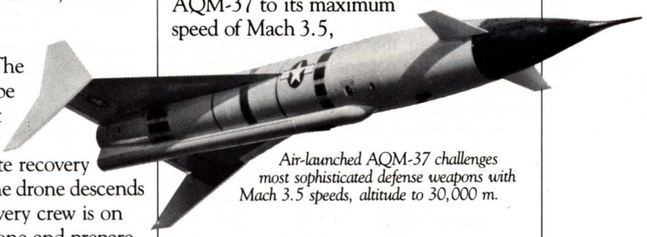
This drone withstands the rigors of a seawater immersion. After being parachuted into the sea, the buoyant MQM-107 floats for water retrieval.

4.
Three-hour turnaround.
Special support and test equipment for the MQM-107 system is simple and easy to operate. Technicians can check out the drone quickly, and ready it for re-use. Targets turnarounds have been accomplished in as little as three hours.

Technical training to service the MQM-107 with your personnel is available from Beech. If you choose, Beech Aerospace Services, Inc. (BASI) will perform MQM-107 support services. BASI now operates the target system for U.S. armed forces, and for many international users of Beech target systems.

5.
High-technology targetry.
The MQM-107 is just one example of Beech leadership in aerial targetry. The AQM-37 air-launched, supersonic target is unique in the free world.

A liquid-propellant rocket thrusts the AQM-37 to its maximum speed of Mach 3.5,

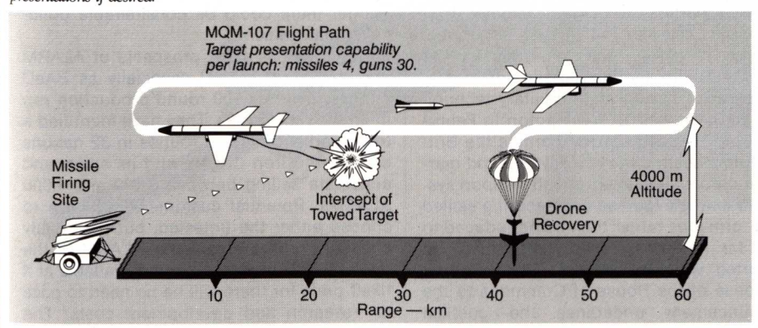


Air-launched AQM-37 challenges most sophisticated defense weapons with Mach 3.5 speeds, altitude to 30,000 m.

and to altitudes of 30,000 m. It flies fast enough, it flies high enough to challenge the most sophisticated defensive weapons – of today, of tomorrow.

For full details of how Beech target systems can boost your nation's air defense readiness, please write: Beech Aircraft Corporation Director, International Aerospace Products Wichita, Kansas 67201 U.S.A.

Air defense missile training exercise shows subtarget "kill"; drone recovery. MQM-107 can make multiple target presentations if desired.



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ALARM bells for British Industry

Demand for anti-radiation missiles (ARMs) has risen with the proliferation of radar-directed air defence systems, but, in the past limitations of technology, size and cost, have restricted their use to a handful of air forces. Recent technological advances make possible more compact and sophisticated missiles which may be more widely available. However immediate potential purchasers face a dilemma following the British Government's decision to make ALARM the RAF's future ARM.

Six years ago the RAF outlined its ARM requirements in Air Staff Target 1228 for a compact weapon, capable of being carried without seriously affecting external loads, by all aircraft having to enter strongly defended air space. Financial restrictions meant AST 1228 was shelved in 1979 only to re-appear months after the South Atlantic conflict showed the urgent need for such a weapon system. The total RAF requirement is for no more than 1,500 rounds, with an initial order for 750 which must begin reaching squadrons in 1986. By the end of 1982 there were two contenders; Texas Instruments' AGM-88 HARM (High-speed Anti-Radiation Missile), which was to be co-produced with Lucas Aerospace, and the British Aerospace Dynamics (BAeD) ALARM (Air-Launched Anti-Radiation Missile), but so finely balanced was the issue that the Cabinet considered the matter five times before opting for the national project.

Production of HARM would have brought considerable benefits both to Lucas Aerospace and the Royal Ordnance Factories, for almost all the RAF rounds would have been produced within the United Kingdom, apart from the Texas Instruments' guidance section which would have had to be bought from the U.S. Government. Some 2,000-2,500 workers would have been involved of whom 83 per cent would have been skilled, including 200 of graduate or equivalent level, while about 90 per cent of the workforce would have been in North West England, West Yorkshire and the West Midlands, areas severely affected by the recession. Lucas would have been able to develop and produce a preflight programmer conceived by Texas Instruments initially for RAF use and later for export to replace USAF-USN on-board equipment with a simple installation permitting the pilot to chose a variety of targets. There was also a proposal that 20-25 per cent worth of the guidance section might be manufactured as components in the United Kingdom for supply to Texas Instruments. The long term, 10-20 years, job prospects were extremely good for there would be access not only to the 20,000 rounds required by the U.S. domestic market but also an export market possibly involving another 25,000 rounds while the co-producers claimed British purchase of HARM would lead to an overall favourable balance of payments surplus of £79 million when the export value of U.K. HARM components was set against the imported U.S. share.

By contrast ALARM's supporters dangled the prospect of £450 million worth of export orders for their system which is planned to be more sophisticated, lighter (190-200 kg compared with 360 kg) and half the price of HARM, enabling it to be carried by a wider range of both fixed and rotary wing aircraft. BAeD and Marconi Space and Defence Systems (MSDS) plan to involve 13 major subcontractors and generate or secure 3,000 jobs, including 900 at the threatened BAeD Lostock plant and 500 with MSDS. Within the Cabinet Mrs Thatcher, Mr Michael Heseltine (Defence Minister), and Conservative Party chairman Mr Cecil Parkinson (Trade and Industry Minister) were reported to support BAeD while Mr Nigel Lawson (the Chancellor) and his predecessor, Sir Geoffrey Howe (Foreign Secretary) supported HARM, possibly because the Government is committed to reducing public spending and the original ALARM proposals were reported to be £100 million more than their rivals.

ALARM's success in winning the £200 million fixed price contract may be ascribed partly to a late restructuring of their proposal to bring it into line with their rivals and partly to a complex mixture of strategic, commercial and political reasons. Strategically the need for an ARM was shown in the South Atlantic conflict and the necessity of developing a domestic product rather than relying on an American one was shown partly in that conflict, with the reluctance of the United States to become involved, and partly by President Reagan's recent attempts to impose a technological blockade of the Siberian Pipeline. It is interesting to note that one of the foremost Government supporters of ALARM, Defence Procurement Minister Mr Geoffrey Pattie, strongly criticised America's treatment of her NATO allies and the Reagan Administration's reluctance to share military technology during a visit to Washington in February. Commercially ALARM permits the British aerospace industry to develop and market another valuable advanced weapon system retaining expertise and securing skilled long term jobs rather than being reduced to what Mr. Pattie has called "tin-bashing" on imported weapon systems. The delighted response of the House of Commons to the announcement underlines the political aspect, that the choice of HARM would have had no impact on votes but ALARM rewards faithful constituencies and helps secure marginal ones. Apart from the Birmingham factory all the major HARM plants were either Labour strongholds or Tory rural constituencies while the majority of the ALARM plants are in industrial Tory-held constituencies, except for Lostock which is a marginal.

While the RAF will be glad to see its ARM requirement secured it will be less happy with the decision, for HARM was its first choice as it would have been available in 1986. By the Government's own admission ALARM will not be available until 9-12 months later i.e. 1987-1988 and it is still at an early stage of development. The project is a considerable technological risk, despite the public confidence expressed by BAeD, and it should be remembered that HARM itself was subject to a seven year development programme which included a redesign; if any problems are encountered it may well push the in-service date unacceptably back or lead to escalating costs which might threaten its existence. The element of uncertainty is extremely unwelcome especially when other air forces will be receiving HARM. However, if all goes well the RAF will have greater operational flexibility for virtually all its combat aircraft, possibly including the HAWK T.1A, which will be capable of anti-radar sorties — the larger aircraft, such as TORNADO, being able to carry four missiles compared with two HARMs.

The ALARM decision is, therefore, a mixed blessing not only for the RAF but also for the British aerospace industry underlining an ever more acute dilemma. For while the project permits the industry to expand its technological frontiers the domestic market, the foundation for any international marketing programme, is steadily contracting and where the field of sophisticated weapon systems is concerned it is miniscule compared with that of the United States e.g 1,500 ARM compared with 20,000 for the U.S. air forces. Unless ALARM is a major export success it could have an adverse long term effect upon BAeD's finances and a concertina effect upon other projects hastening the end of the day of purely national sophisticated weapons systems. The Government is unlikely to be able to help BAeD if it does have trouble, for the costs of both the TRIDENT project and "Fortress Falklands" are already heavy and likely to become more burdensome, and if ALARM too were to go substantially over budget there could be considerable political embarassment.

The overseas sales prospects of ALARM are, therefore, crucial especially as BAeD budgeted for a 2,000 round production run in all their proposals. They have identified a total market of 14,000 rounds in 32 nations outside the Iron Curtain and its allies, and anticipate selling between 3,500 and 4,000 ALARMs. Potential customers will have to choose either the untested, but potentially cheaper and more versatile, ALARM or the tested HARM which should be available at a fixed price for there will be no need to pass on research and development costs. The customers may decide to delay a final choice until they can observe the progress of the ALARM programme, which might have an adverse effect upon NATO's opera-

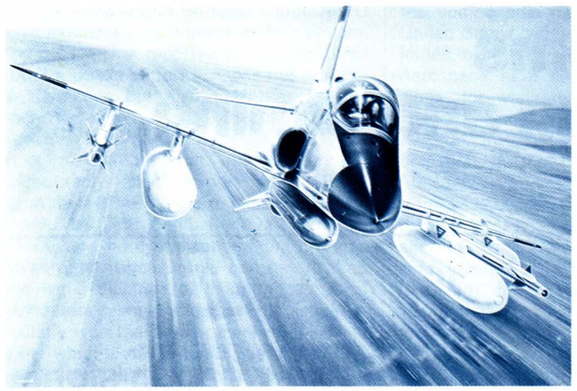
tional capability or they may decide to opt for HARM because it is readily available. The logistics benefits of having an American missile may also improve HARM's sales prospects and Texas Instruments state only France, Norway and Portugal within NATO have expressed no interest in their system. The company is reported to have acquired about a dozen export licences not only for NATO states but also for other friendly nations such as Israel, Saudi Arabia, Australia, South Korea and Japan. Development of the preflight programmer will undoubtedly assist export sales. BAeD claim their SPARROW-size missile could be carried by light combat aircraft such as HAWK, or even by helicopters, but it seems unlikely the former could carry more than one while the idea of mounting them on helicopters seems somewhat optimistic particularly with the development of specialist light weight ARMs such as SIDEARM. Should a customer decide to purchase ALARM instead of HARM, or even the export version of Matra's ARMAT, there is no guarantee of a sale because of fears for security: indeed the Ministry of Defence is reported to have given Marconi considerable difficulties selling the STINGRAY torpedo precisely because of this reason.

The British industry's alternative to national weapon system projects is international development or a co-production venture but United States companies in particular will hardly have been encouraged by the British Government's decision. For Lucas it is especially disappointing for only two years ago their proposals to co-produce the Gould Mk 48 ADCAP torpedo were rejected and their participation in the development of the HARM pre-flight programmer must be in jeopardy. The Lucas organisation had hoped to slow down the decline of their work force and strengthen their position in the components market, especially in the United States, where they might have been joined by more British companies. Lucas Aerospace have certainly found it worthwhile, for while their earnings in United Kingdom missile projects rose from £945,000 in 1978 to £1,927,000 in 1983 participation in the HARPOON, HARM and AMRAAM programmes saw earnings rise from £132,000 to £5,502,000 in the same period. Lucas, therefore, are offering an alternative to the industry which is profitable, involves long term programmes and, frequently, technology transfer; the organisation has also shown its capabilities as project managers. Such a policy could see the production of a foreign weapon system to which might later be added significant British technological improvements but whether or not this is nationally acceptable is the key question.

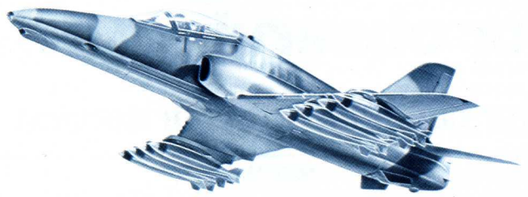
For ultimately the British rejection of HARM may be regarded as a further sign of growing European self awareness as the EEC gains political strength and evolves policies significantly different from those of the United States underlining the need both for a re-evaluation of trans-Atlantic relationships diplomatically, and strategically. President Reagan's technological dictate earlier this year may well have been a powerful argument for rejecting HARM and there is a strong feeling within Europe that the United States is not whole-heartedly committed to the Two-Way Street while its defence industry is trying to undermine its European competitors. The feeling may be exaggerated for there has been a considerable amount of standardisation within NATO despite conflicting national and commercial interests. True, the history of the alliance is littered with the wrecks of collaborative projects but their need, and value, is recognised, as is the European refusal to play second fiddle to American industry. Increasingly the alliance must examine its weapon system requirements carefully, organise co-production and assign project management carefully between the continents, and there are signs that this policy is being accepted with the AMRAAM-ASRAAM agreement and the recent Conference of National Armament Directors' decision to study air-to-surface weapons and seek both national requirements and technological proposals.

Although such measures may prove more time consuming than purely national projects they seem more likely to preserve the vitality of the West's defence industries. From the view of the alliance as a whole, the ALARM decision may be regarded with regret for a collective purchase might have had great operational benefits but by making an alternative system available BAeD may well be helping both NATO and the West in general by providing a more advanced missile. The British Government has taken a gamble while at the same time passing a massive vote of confidence in the national aerospace industry. Time will tell whether or not that gamble has paid off.

MILTECH



An artist's impression of a HAWK Series 200-100 in the Maritime Strike role with radar in the nose. This could be BLUE FOX or BLUE FALCON or some similar sized equipment.



An artist's impression of a HAWK Series 200-60, essentially a single seat Hawk 60. BAe may have a demonstrator flying by 1985.

BAe's HAWK sharpens its talons

With few new combat aircraft at the Paris Air Show and attention largely focussed on the forthcoming battle between EAP/ACA and ACX/ACT, few noticed that British Aerospace's HAWK trainer is beginning to sharpen its talons.

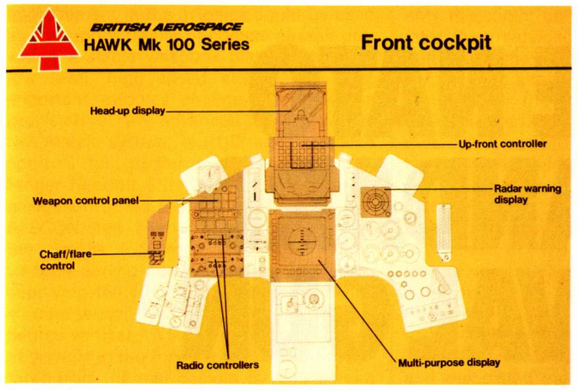
The appearance of a HAWK armed with a SEA EAGLE anti-ship missile, underlined the fact that the BAe Kingston-Brough Division is now actively considering two new versions, Series 100 and Series 200, which would take the design further across the spectrum from trainer to combat aircraft exploiting the performance, agility and load-carrying capabilities of the design to produce a relatively unsophisticated, yet still potent, combat aircraft with an appeal to the larger air forces and which could be co-produced with smaller nations. The HAWK trainer, having been selected by the RAF and six African, Middle Eastern, Far Eastern and Scandinavian Air Forces as well as the U.S. Navy for the VTXTS programme, could offer a comprehensive family of trainers and combat aircraft with common spares and ground support equipment, as well as providing more efficient use of manpower by retaining air and ground crew expertise.

By examining the pedigree of this thoroughbred family it is easy to understand BAe's philosophy of exploiting the great design potential to enhance combat capabilities. The HAWK T.Mk 1, powered by the Rolls Royce-Turbomeca ADOUR Mk 151 with 24.2 kN (5,340 lb) static thrust, entered RAF service in November 1976. Since then 176 have been bought for flying and weapon training, aircraft in the latter role having the Ferranti ISIS D-195R weapon aiming sight, a centre-line gun pod with 30mm ADEN Cannon and 130 rounds of ammunition, and a pair of inboard pylons to carry practice bombs and rocket launchers. Soon after it entered service the growing threat from Soviet aircraft made the RAF acutely aware of its own paucity of reserves and a HAWK War Role was devised which incorporated a lot of the experience which Kingston had gained with the export Series 50. The Division's Dunsfold factory is currently responsible for the HAWK War Role Programme-retrofitting the 88 HAWK weapon trainers with a Louis Newmark attitude and heading reference and installing the interface for a pair of SIDEWINDER air-to-air missiles on wing stations. The work takes three months per aircraft which is then designated HAWK T.Mk 1A. They will supplement Strike Command's home defence force acting as point defence interceptors and in the ground attack role with a variety of ordnance.

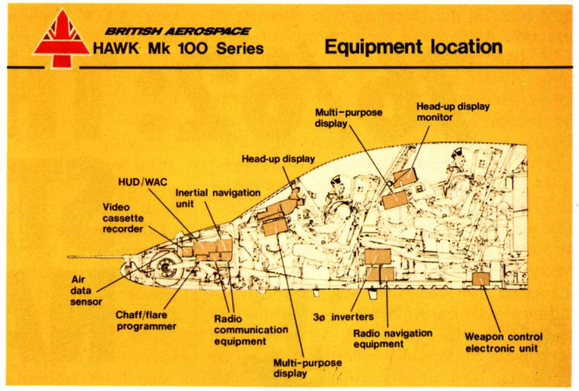
A HAWK T.Mk 1 demonstrates the potential of the aircraft in the Maritime Strike role with a SEA EAGLE anti-ship missile, two SIDEWINDERs and two 860 litre drop tanks. This aircraft appeared at Paris.

The export Series 50, with the modified ADOUR Mk 851, which improved acceleration time — making the aircraft more responsive, had outboard pylons added so that the inboard pylons could be used for 590 litre (130 gallon) drop tanks as well as ordnance. Each pylon has provision for twin store carriage and is cleared for 515 kg (1,135 lb) at 8g, and about twice this at slightly reduced levels of g. The avionics were improved with the addition of a weapon control system including the Louis Newmark attitude and heading reference together with an angle-of-attack indicator which is now being proposed for the HAWK T.Mk 1. The maximum operational weight, at 7,350 kg (16,200 lb), was an increase of 30 per cent on the T.1 but the maximum disposable load was increased by 70 per cent and maximum range by 30 per cent. The Series 50 was bought by Finland (50 Mk 51, most of them co-produced), Kenya (12 Mk 52) and Indonesia (20 Mk 53); further sales are anticipated by BAe.

It has largely been surplanted in the export market by the Series 60 which has greater combat potential while retaining its training role. The uprated 25.4 kN (5,700 lb) static thrust ADOUR Mk 861 offers a 17 per cent increase in take-off thrust or 10 per cent in operational conditions. The wing lift co-efficient has been improved with the four breaker strips replaced by six mini-fences while a mini breaker-strip has been added to the main fence to improve turning performance and handling qualities, permitting



A drawing of the front cockpit layout of the HAWK Series 100. A working, ground demonstrator is currently being developed.



Equipment location in a basic HAWK Series 100. An enhanced version would include FLIR camera in the air data sensor compartment (with modified nose) and a moveable laser rangefinder below the radio navigation equipment compartment.

the HAWK to go deeper into buffet thus providing more useable g in combat conditions. A four position flap replaces the three position one, further improving take-off. The maximum external load is 3,265 kg (7,200 lb) and the inboard pylons are now capable of carrying a 860 litre (190 gallon) drop tank for ferrying or combat roles with reduced load factors. All Series 60s are built to accept SIDEWINDER-type missiles, up to two on each outboard pylon, and the company are currently clearing the MAGIC R.550 for the HAWK. Some HAWKs have also been modified to take reconnaissance pods, with photographic and linescan systems, to meet customers' specifications, a special control panel being added to the rear cockpit.

The maximum operating weight of 8,600 kg (18,960 lbs) of the Series 60 is 17 per cent heavier than the Series 50, features a 33 per cent increase in disposable load and there is a 30 per cent increase in maximum range, the ferry range with 860 litre tanks being 4,032 (2,176 nm) compared with 3,217 km (1,736 nm), and there are improvements in speed (maximum level speed being 560 knots or 1,040 kph), turn and climb rate. Operationally it has a radius of action of 1,222 km (660 nm) in a hi-lo-hi mission with two 450 kg (1,000 1b) bombs or 510 km (275 nm) with seven 450 kg bombs. For a close support mission the radius of action would be 678 km (366 nm) with two 450 kg bombs and two 860 litre drop tanks permitting a two hour loiter. The Series 60 had been bought by Zimbabwe (8 Mk 60s), The United Arab Emirates (reportedly 8 Mk 61s for Dubai and 16 Mk 63s for Abu Dhabi) and 24 Mk 62s were reportedly selected by Venezuela.

The philosophy of the Series 100 and Series 200 is to retain the basic Series 60 design with its proven qualities and enhance the combat capability. The Series 100 has been called the Enhanced Ground Attack (EGA) version and with a significant

improvement in the avionics could be used as a weapons trainer or combat aircraft providing a stable weapons platform for very low level, high speed attack. The most important avionics change would be the provision of an advanced digital inertial Nav/Attack system, a HUD and improved controls for greater pilot efficiency. The Singer Kearfott SKN 2416 dry gyro inertial navigation unit, used in the F-16 FIGHTING FALCON, has been chosen together with the Smiths Industries' 263 SUE/1 HUD-weapon aiming computer; Smiths are also supplying the 101 FAD/1 high performance air data sensor. The HUD, with its large (16.5 degree vertical, 17.5 degree horizontal) field of view, is in the forward cockpit and monitored from the rear cockpit by a TV screen with video recorder. Both controls feature a Smiths 709 SUM/1 four colour, high brightness, multi-purpose CRT primarily for managing attitude and navigation display although changes in software mean it can be altered to meet customer specifications, for example the provision of a radar warning facility, although a separate radar warning indicator could be fitted. The reliable, easy to install, 1553B digital data bus will make it easy to add on new units.

A major aid to pilot efficiency is the provision of HOTAS (Hands On Throttle And Stick) with all essential controls for operational purposes literally at the pilot's fingertips, attack system selection switches being on the control column while the throttle handle features selection and control switches for navigation, engine, airbrake and electronic warfare systems. An improved weapons management system allows pre-selection during flight and displays weapon status while featuring manual or automatic weapon release.

The HAWK Series 100 would have a maximum take-off weight of 8,570 kg (18,890 1bs) and would be able to carry the same maximum load and have the same maximum speed as the Series 60; having similar radii of action with the same offensive loads e.g. with two 450 kg bombs it would have a lo-lo mission radius of 565 km (305nm) including 93 km (50 nm) dash. It could prove surprisingly effective against even sophisticated defence systems thanks to a low radar cross section and a low infra-red signature augmented by a radar warning receiver and chaff flare dispensers which could be supplemented by a centre line or inboard pylon mounted ECM pod. The Series 100 would be capable of carrying sophisticated air-to-ground ordnance, including laser-guided bombs or the AGM-65 MAVERICK missile which could be controlled from a modified rear cockpit position, each pylon being capable of carrying one MAVERICK although twin rail launchers are being considered. The aircraft would be suitable for combat air patrols and would be able to loiter for 3½ hours up to 260 km (140 nm) from base with two 860 litre tanks and armed with two air-to-air missiles and a 30 mm gun.

An extended operational capability version is also being considered with integral FLIR camera in nose extension to give, with modified HUD- weapon aiming computer and pilot night-vision goggles, a low level, night time capability. This could be supplemented with steerable, high pulse repetition frequency Nd YAG laser installed under the fuselage for greater accuracy in low level attacks over uneven terrain. Presumably this might be replaced by a CO_2 laser later for greater accuracy in mist, haze or battlefield smoke conditions.

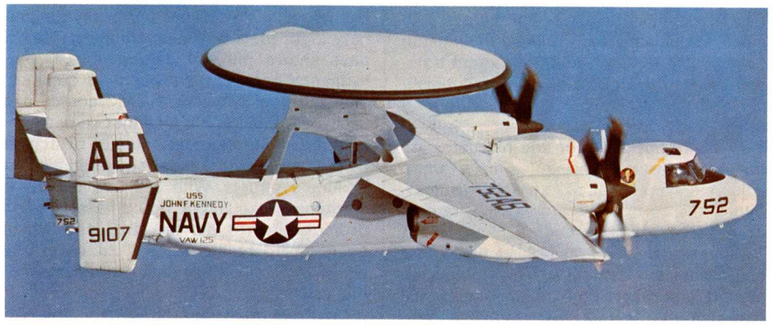
As a light attack aircraft or weapon systems trainer the HAWK Series 100 could meet the needs of many air forces, even the most sophisticated; indeed Kingston believes there might be an important training role for the aircraft in the most sophisticated air forces. Many of them feature long range, multi-role strike aircraft with two-man crews but the pilot and navigator are trained separately and must make sharp adjustments at various training stages. Pilots receive flying and weapons training on unsophisticated aircraft, such as HAWK T.Mk 1, while navigators receive their radar and associated training in slow, multi-seat, aircraft and when both reach operational conversion units they must assimilate operational procedures while adjusting to more powerful aircraft and extremely sophisticated equipment such as HUDs and weapon aiming computers. Kingston believes most of the first tour with a frontline squadron is spent gaining proficiency with the aircraft and its systems rather than gaining operational efficiency and suggests the solution is to introduce the Series 100 allowing the student to gain proficiency with the electronic tools of his trade while flying a simple, but familiar, aircraft. The navigator too could benefit from early experience of his operational environment aided by the introduction of a radar pod. Whether or not training organisations agree and are prepared to divert some of their limited funds to such a project remains to be seen.

The two-seat configuration does pose restrictions on the combat potential of the HAWK and BAe designers have not been slow to appreciate this point nor the advantages of offering a cheap, but effective, tactical fighter which would capitalise on existing logistics and training. Several years ago design studies began and have crystalised in the shape of the Series 200 which would feature a new nose section forward of the Series 60 wing leading edge but the original aircraft aft of this point. The pilot seat would be slightly forward of the old rear position and raised a few centimetres, while the forward landing gear would be moved further to the rear to increase nose volume for sensors — a pair of cannon with their ammunition would also be added. The initial option would be the 30mm ADEN with 150 rounds per gun followed by the 27 mm Mauser or, alternatively, the 30mm DEFA 552/553.

Two basic versions are planned; Series 200-60 and Series 200-100, which are essentially single-seat versions of the Series 60 and 100 respectively. In an interdiction mission with four 450 kg bombs either could have a hi-lo-hi radius of 1,055 km (530nm), for a close support mission, a 250 km (130 nm) radius with seven 450 kg bombs would be possible while for a low level armed reconnaissance mission with centreline pod and air-to-air missiles the radius would be 665 km (380 nm). A more sophisticated version of the HAWK 200-100 with more sensors, such as FLIR and laser rangefinder, is also proposed and this could also carry air-to-surface missiles or even the new range of lightweight anti-radiation missiles such as SRARM or SIDEARM. With radar such as Ferranti's BLUE FOX or BLUE FALCON, an airspace denial version armed with AIM-7 SPARROW or SKY FLASH missiles would be capable of cruising 87 km (50 nm) from base for up to four hours with 860 litre tanks. The radar would also lead to a maritime strike role for the HAWK when armed with the SEA EAGLE missile which has just been sold to India. BAe say preliminary flight trials with a conventional HAWK have shown minimal degradation in performance and excellent handling qualities. The existing two-seat HAWK could also carry SEA EAGLE, but it cannot carry a suitable radar, although this could be overcome by teaming it with a radar-equipped aircraft to locate targets. With 860 litre tanks the Maritime Strike HAWK would have a radius of more than 1,290 km (820 nm) which could, incidentally, allow it to cover the whole of the North Atlantic from surrounding land bases.

Dual role attack aircraft, such as the Aermacchi MB 326 and the ALPHA JET, have proved successful in the light tactical role throughout the world while the Aermacchi MB 339 further demonstrated the potential by sinking a British frigate in the South Atlantic, so Kingston foresees a good market for both HAWK 100 and HAWK 200 which would have superior performance and load-carrying abilities compared with contemporary trainer-based designs and, in the case of HAWK 200, would be capable of replacing combat aircraft such as the MiG 17, HUNTER, A-4 SKYHAWK and F-5 FREEDOM FIGHTER. Surprisingly the HAWK 200 could prove a serious competitor to such sophisticated export fighter designs as the MIRAGE 2000 or the F-20 TIGERSHARK despite their apparent advantage of supersonic performance and more sophisticated electronics. The unit price of the HAWK seems likely to be substantially lower than these more sophisticated competitors which might be a further attraction to customers who may also not have the expertise or financial resources to maintain a force of advanced fighters. Nor need the difference in performance be so serious a disadvantage for this can be compensated for with missiles and agility, the latter attribute being a feature of the latest fighter designs. It is interesting to note the agile, missile-armed fighter in the shape of BAe's SEA HARRIERS and HARRIERS, clearly demonstrated the advantages of the concept against higher performance fighters such as MIRAGE III and KFIR over the South Atlantic, the latter being so thirsty they were unable to stay long over the battle zone.

BAe will shortly be deciding whether or not to fund a HAWK 200-60 demonstrator, using one of the stock-built airframes, and this could be flying by 1985. Meanwhile a working, ground-based, developer programme for the HAWK 100 is already under way. The ambitions of the HAWK design team, however, remain unbridled. Having gained the U.S. Navy's VTXTS contract, for which the HAWK will become the T-45, they now have their eyes set on the USAF's T-38 TALON replacement while on the combat side they are considering a HAWK 200 with uprated engine and developed wing as the basis for a HAWK Strike Fighter, a multi-role combat aircraft which could meet RAF requirements in the 1990s. Whatever their success with this particular design the HAWK will undoubtedly be serving with air forces big and small throughout the world well into the 21st Century.



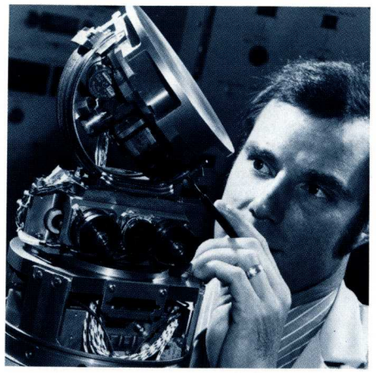
Air control aircraft such as this E-2C HAWKEYE are a key element for air defence: consequently, the characteristics of their radars must be optimised to withstand ECM as well as to cope with the likely future threat of air-to-air ARMs.

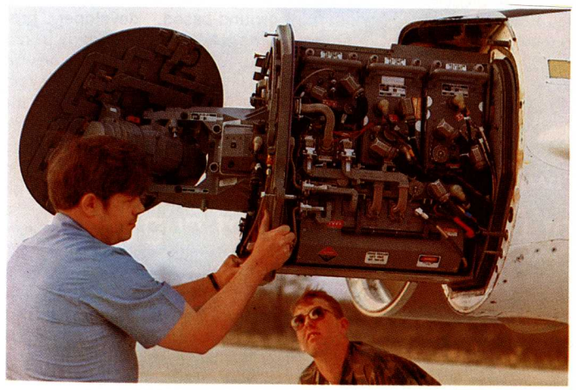
Norman Friedman

Airborne ECCM

Electronic Counter-Counter Measures, ECCM, is the art of nullifying the armoury of countermeasures developed to defeat existing radars. Generally ECCM refers to design features which can be incorporated in a radar, although in some cases ECCM tactics can also be identified. In some cases the entire radar concept of operations can be changed to avoid or to overcome standard Electronic Counter Measure (ECM) techniques. Probably the single best publicized form of ECCM is "stealth", in that it purportedly denies an enemy the ability to detect the active radar signature of the attacking airplane.

In what follows, the primary radar characteristics are frequency (which equates to wavelength), antenna size (in wavelengths), and mode of operation, which includes the extent of data processing. The higher the frequency, the shorter the wavelength, and the more distinct frequencies there are close enough together for a single physical radar configuration to operate on any of them. That is, the actual dimensions of radar transmitter, waveguides, and antenna determine the range of available frequencies. Until very recently, X-band (3 cm) marked the upper limit in practical radars; one of the major developments of the last decade was the extension up into K-band the wavelength of which is 1 cm or less; with some systems functioning at about 3 mm (94 GHz), or ten times the frequency of X-band. For a given beam size (in angular terms), a radar antenna must be of fixed size in wavelengths; in theory then, a dish 20 cm in diameter functioning at X-band is equivalent to one about 2 cm in diameter operating at a frequency ten times higher (high K-band). However, transmitter power appears to fall off at higher frequencies, and propagation through the atmosphere is more difficult.





The flat antenna of the active radar homing system which guides the AIM-120 AMRAAM air-to-air missile in the terminal part of its trajectory.

The AN/APG-65 for the F/A-18 is one of the few multi-mode radars currently available.

Airborne radars fall into three general categories: air intercept sets, which are primarily (though not entirely) for fire control, including missile control; ground mapping sets for air to ground fire control, reconnaissance, and navigation; and airborne early warning sets such as the radars in the Grumman E-2 HAWKEYE and in the Boeing AWACS. There are also a few truly multi-mode radars, such as the APG-65 of the McDonnell Douglas/Northrop F/A-18, which combines air-to-air and ground-mapping features.

In one important case, ECM/ECCM tactics affect not only a single class of radars, but a system in which two very different classes of radars are linked together. That is, in a typical air defense system, fighters equipped with relatively short range air intercept radars are vectored into attack positions selected on the basis of air or surface warning radars, so that the fighter interceptor system can be disrupted by attacking either radar system. To some extent giving the fighter-borne sets additional power is an ECCM measure, in that it can compensate, to a limited degree, for the loss of the main control radar system. As a case in point, reportedly the Iranian Air Force has used its Grumman F-14 fighters as early warning aircraft, exploiting the long effective range of their AWG-9 radars. Yet in U.S. service, the F-14 is always paired with the E-2C radar aircraft.

In recent years, a school of thought has developed in the United States holding that active radar, as in the F-14 and F-15, is in itself dangerous because it invites attack by anti-radar weapons. At the least, it is argued, a powerful air-to-air radar can be detected at a great range, permitting the prospective target to evade. For example, in tests, pilots flying F-5s equipped with primitive radar warning receivers were able to detect and evade F-15s armed with long-range SPARROW semi-active homing missiles. The issue for ECCM is the extent to which such evasion can be prevented in future. The other major current issue is the extent to which a bomber, which might have to rely, at least in part, on ground-mapping radar, would be able to avoid detection by Soviet radar receiving equipment. Only slightly less urgent is the question of whether the U.S. fleet air defense system, which depends heavily on both airborne and ship-borne radars, can operate effectively in a jamming environment. Although this last is most often expressed as a question of AEGIS effectiveness, in fact it is at least as much directed at the APS-125 of the E-2C air control plane. The Soviets in particular are known to be devotees of electronic warfare, and their standard tactics for stand-off bomber attacks against carrier battle groups call for heavy jamming and the lavish use of chaff corridors behind which bombers can fly.

ECM falls into two broad categories: measures to detect an airborne radar (radar warning receivers), and measures to defeat an already-detected radar: jamming, decep-

tion (such as chaff), and physical destruction by means of radar-homing missiles. At the time of writing, no air-to-air anti-radar missile (ARM) is known to exist, but such weapons would be a natural counter to airborne battle management aircraft such as AWACS, and anti-ARM measures are therefore relevant here.

Radar warning has received considerable publicity for two reasons. First, long-range air-to-air missiles such as the SPARROW have been criticized because they require sustained radar illumination of the target aircraft, which can detect that illumination and either evade or counter-attack. Second, discussions of the stealth projects have emphasized the need to eliminate the active radar signature by means of which an aircraft using a ground-mapping system might be detected. For example, reportedly one stealth system is small reconnaissance aircraft, which presumably requires active sensors to operate in adverse weather. Concurrent with stealth development, then, there has been increased interest in Low Probability of Intercept (LPI) radars.

There is really no ideal electronic solution to the SPARROW problem. If the missile homes on reflected radar emissions, then the illuminating beam must be intense enough for those reflections to be distinguishable from the surrounding noisy background, and in general, a radar search receiver will be able to detect the beam at a greater range than can the missile. The only hope is that the search receiver will not be tuned to the proper frequency. For example, one might imagine an illuminating beam jumping from frequency to frequency in a pre-programmed way. The higher the base frequency, the greater the number of alternatives, and the more difficult the task of the search receiver. At best this is a very complex solution. It appears to be much simpler to pass from semi-active homing to a small active seeker in the missile itself, a solution adopted in the SPARROW follow-on, the Hughes AIM-120 AMRAAM. This solution has not previously been adopted primarily because it was only recently that effective radar transmitters in the very short wavelength required (K-band) have become available. Note, however, that almost twenty years ago the much larger Hughes PHOENIX (AIM-54) already incorporated an active terminal seeker; that was because the missile was so large that the use of X-band was practical.

LPI is still a developing rather than a developed technology, but if stealth is practical it will surely incorporate LPI sensors. The basic concept appears to be to transmit simultaneously on a wide variety of frequencies, with so little energy in each that the emission cannot easily be distinguished from noise. However, when the different signals are added together, they have enough net energy to be useful. Clearly there are many problems here; radar signals of different frequencies do have different propagation characteristics and antennas must be large enough to form beams in a variety of wavelengths. One can speculate that the key technology is electronically-scanned antennas, which can form many beams simultaneously and which can be controlled by the current and future generation of very high speed integrated circuits. Yet another possibility is elaborate coding, using relatively long signals which might be noise-like. Again, a precondition is a data processor that is fast enough to extract the coded information. The reader might note that the B-1B is sometimes described as a partly stealthy aircraft, and that its ground-mapping radar employs an electronically-scanned antenna. Note, too, (that reportedly) there are LPI communications systems as well, using apparently noise-like signals.

The classic means of defeating radar are noise or barrage jamming, deception jamming, and decoys, particularly chaff. Noise is the simplest; enough energy is poured directly into the antenna to swamp any signals the radar may detect. However, if the jammer is pointed directly at the radar, the radar operator can at least track it in bearing. A more sophisticated approach is to pour the jamming energy into the radar side-lobes. That is, the radar, looking in one direction, also (in general) receives some energy from other directions, albeit at lower levels. It cannot distinguish between signals in the side lobes and the mainlobe, and must depend upon the much higher gain in the main lobe to make the difference. If enough energy is poured in, the difference in gain can be overcome, and the radar can be jammed. Similarly, a radar with a very broad main beam will gather energy from a much larger volume of sky than a narrow-beam system. That makes it easier for a jammer to cover a nearby radar target, since the radar cannot distinguish between targets in its beam.

There are several levels of ECCM that can be used to cope with noise jamming. Jamming is typically done at the frequency of the radar, the jammer being switched off briefly to check whether the radar is still operating on the jamming frequency; that is, the noise of the jammer is concentrated on the one narrow frequency band; on the other hand the noise can be dissipated across a spectrum (barrage) of frequencies. In the latter case, the higher the frequency, the wider the spectrum and therefore the more difficult the task of the barrage jammer. Thus a key ECCM technique is to hop from frequency to frequency faster than the jammer can detect the changes, and that requires some considerable sophistication in the radar itself.

The alternative is brute force. If the radar is powerful enough, no jammer can impose enough noise to defeat it altogether. This was the approach observed in the Soviet MiG-25. Such a system, however, should be vulnerable to sophisticated deception jamming.

At a more basic level, the radar designer can seek lower side lobes and a narrower main beam. (The APS-125 radar of the Grumman E-2C is sometimes criticized on this basis: it operates at a relatively low frequency (UHF) and therefore has a broad beam susceptible to sidelobe and to off-axis jamming. Grumman counters that the same lack of definition also ensures against effective ARM attack, as no airborne missile is likely to carry a big enough antenna to home effectively on a metric-wavelength radar.) Typically, the counter to sidelobe jamming has been narrower radar beams with small sidelobes and or with sidelobe cancellers. For example, the shipboard SPS-49 has a higher frequency than its predecessor, the SPS-40, and it was specifically designed with a narrow, stabilized beam which would reduce the chance that a jammer near a radar target would pour its energy into the beam. In airborne early warning radars, the APY-1 of the Boeing E-3A represents a similar approach, and proponents of this airplane often refer to its resistance to noise jamming.

There are many forms of deceptive ECM, and the generic ECCM measure is to increase the amount of information the radar extracts from its signals so as to make it more difficult for the jammer to simulate a real target. Doppler radars and Moving Target Indicators, for example, measure target speed, and can be programmed to exclude slow targets such as clouds of chaff. Such measures do not, however, provide a means of seeing through clouds of chaff — nor, for that matter, rain clouds. The solution to those problems is most likely a very high definition beam with a very short pulse width, making for small resolution cells from which effective data processing and data extraction is possible. That is the approach represented by the shipboard SPY-1 (AEGIS) radar, which reportedly has excellent performance even in severe rain. In the past one means of overcoming chaff was to employ relatively long-wave radars whose beams tended to bend around the chaff. Such radars are not currently very practical in most aircraft due to their size. However, one can imagine future systems employing conformal radars in the leading edges of the wings, and which would encounter no such physical limitations.

With the spread of very high-speed data processors, the level of information available to a radar system trying to decide whether a signal is a real target (which is very nearly the definition of one class of ECCM) has greatly increased. For example, Fast Fourier Transform techniques allow extraction of velocity information from conventional pulse radars. Recently some of these techniques have been proposed as replacements for conventional forms of IFF. They include include computer-processed extraction of target configuration (including size) and means of detecting a turbine blade rate, presumably by doppler. In each case, the same type of data analysis would greatly improve ECCM performance. Similarly, automatic tracking of airborne targets, which is a feature of some current systems, allows computers to analyze the apparent dynamics of the targets, and thus to check whether that motion is physically plausible.

From its inception, airborne radar has been both the salvation and the doom of military aircraft; the salvation, because it permitted them to fly at night and in bad weather; the doom, because its signals gave away their location and also because those same signals could be turned against their emitters. Some of the recent arguments against powerful airborne radars are really ECM arguments; the question is whether ECCM techniques can cope. If they cannot, and we cannot employ our radars, then we cannot fight in the sort of bad-weather environment which Central Europe presents most of the time. Fortunately, it appears that the combination of higher frequencies (as in AMRAAM), and very high speed data processing will keep those radar-equipped aircraft viable — if the new technology can be implemented as it develops.

MILTECH Electronic News

Racal's Combat Net Radio Simulator

Racal SES Ltd has produced a simulator which provides realistic battlefield combat net radio conditions in the classroom.

Communication exercises, including jamming, interception and re-broadcasts are run on a range of standard maps — UK and overseas — while the students remain in the classroom or in communication vehicles grouped round the simulator. Sophisticated computer algorithms — given the precise map co-ordinates of each radio station — calculate the terrain dependent path between installations and insert the necessary level of attenuation to emulate exactly the real radio path.

In this way the effects of siting and terrain on the performance of complete radio networks can be simulated, allowing operators to gauge the best sites for longest range; the locations most resistant to enemy jamming and those least susceptible to interception. The system also allows for the tactical positioning of radio re-broadcast stations needed to overcome otherwise difficult radio paths.

The first simulator has been installed at the British Army School of Signals at Blandford in Dorset. It has been found that it eliminates the necessity for field communication exercises which always meant a heavy expenditure in time and equipment.

Racal is now working on a transportable version which can be taken to units and formation HQs requiring regular training in authentically simulated battlefield combat net radio communication.

A New Video Image Processor

from Hughes Aircraft Industrial Products Division, converts radar or sonar video signals to TV raster scan for display on local or remote monitors or for recording on video tape. Stored information can be displayed simultaneously with dynamically updated information, and the image can be viewed in normal ambient lighting.

A vertical gray calibration scale appears at the side of the radar/sonar display, and alphanumeric legends and messages can be overlayed on the image or written in designated locations outside of the displayed image area.

Memory consists of MOS dynamic RAMs organized 512 × 512 × 4 bits and image resolution is 512 pixels per line × 480 m lines. The unit is microprocessor controlled with up to 8K bites of programme memory and 768 bytes of RAM to execute processing commands. Analog sweeps can be entered with sweep speeds up to 51 microseconds full scale and pulse repetition frequency up to 1,000 Hz.

Cossor to supply SEA KING helicopters with IFF

Cossor Electronics has received an order from the British MOD to supply a variant of the company's IFF 3500 airborne interrogator for use by SEA KING helicopters. Known as IFF 3570, it is designed to integrate with the Thorn EMI SEARCHWATER radar. Initial trials will take place later this year. The IFF 3500 series is being fitted to the British AEW NIMROD, the TORNADO ADV and the PHANTOM. It is a high performance interrogator enabling an aircraft in flight to positively identify another friendly aircraft or ship.

A high standard of target resolution is achieved by the use of monopulse bearing measurement which overcomes many of the problems of large antenna beamwidths from small airborne antennas. Special circuits reduce the effect of reflections from the ground or the sea. The system also incorporates an automatic code changing system which eliminates the possibility of incorrect code setting and reduces the workload of the pilot and crew.

Cossor expect to produce several hundred of the IFF 3500 series and estimates that, with this order, the overall value of the full development and manufacturing programme will exceed £25 million.

Remote controlled HF receiving system

A new remote controlled HF receiving system for unmanned operation with routine watch keeping duties performed automatically under computer control, the PRS 2280, has been launched by Plessey Radio Systems. It comprises a family of standard modules which can be flexibly linked via data-bus to give a wide range of different systems according to user specifications.

Available receiver types include the PRS 2281 — remote controlled; the PRS 2282 — stand alone, local or remote; and the PRS 2283 — slave receiver. Up to 65 individual receivers can be controlled from a single data bus. 100 memory channels are provided and memory entry and inspection are possible without affecting the receiver operation. Each module includes BITE (Built-In Test Equipment) with automatic fault indication. The System is remote controlled through an RS 232 fiberoptic or IEEE interface, with provision for control of antennas and other external devices.

Receiver of the PRS 2280 HF remote controlled receiving system launched by Plessey Radio Systems. Up to 64 individual receivers can be controlled from a single data bus.

Falklands military airfield electronics equipment

It is the first time a contract has been let by the Ministry of Defence (MoD) to a commercial organisation for the technical co-ordination of work at a military airfield. Plessey Airports Ltd has been awarded a contract to design, manage, and co-ordinate supply and installation of all the Government furnished electronics and communications equipment for the new Mount Pleasant airport in the Falklands.

Plessey Airports will be responsible for overall systems and installations design including such Quality Assurance as required to establish a full operation airport, and will work very closely with the Property Services Agency (PSA) and the contractors Laing, Mowlem and Amey Roadstone.

In view of strategic consideration, all the services, Royal Navy, Army and Royal Air Force will be involved in the specification of the operational requirement, the complete design and ultimately the operation and maintenance.

Flight Data Recorder for BAe Warton ACA Demonstrator

The new SCR 300 series flight data recorder manufactured by the Bracknell Division of British Aerospace Dynamics Group, currently in service on JAGUAR and various other military aircraft has been selected for the new Agile Combat Aircraft (ACA). The SCR system comprises two units, a crash protected flight data and voice recorder and a Data Acquisition Unit.

The ACA is Britain's most important military aircraft project being designed as a replacement for the PHANTOM in the early 1990's.

Marconi Avionics delivers first production FOXHUNTER

The first series-production FOXHUNTER radar for the RAF's TORNADO ADV fighter has been delivered by Marconi Avionics Ltd (now a separate company and no longer a division of the Marconi Group). The radar is the first of an initial batch of 20 for delivery to the British MoD.

Known as AI24 in the RAF and designated FOXHUNTER by the manufacturer, it is the first pulse-doppler air combat radar of British design to go into production. It will provide the TORNADO's air crew with a very good capability for long-range detection of targets at any altitude in both look-down and look-up situations, over land and over sea, with a track-while-scan mode. Target track parameters are provided for the direction, launch and control of medium and short range air-to-air missiles (AMRAAM and ASRAAM), as well as the firing of the aircraft's 27 mm gun. In addition, the FOXHUNTER provides target illumination for semi-active radar homing missiles such as SKY FLASH. The pilot can, at any time, call on the radar for rapid acquisition and fire control on visually acquired targets of opportunity.

The FOXHUNTER operates in I-band, with a Cassegrain antenna, and features exceptionally developed ECCMs. Its development started in 1974, with Ferranti (responsible for scanner and transmitter) as major sub-contractor; first flight of FOXHUNTER on a TORNADO F.2 took place in June, 1981, and pre-production radars have been flying since early this year. All radar modes have already been demonstrated, showing a high performance and a high degree of integration with the avionic suite and weapon system which gives the aircraft a significant advantage and a high kill probability. FOXHUNTER is mainly designed to operate integrated within the overall UK air defence network, to which it is related through the JTIDS (Joint Tactical Information Distribution System) which equips the TORNADO ADVs.

Manufacture of the next batch of radars is already well underway, and interest in the system by other air forces is reportedly growing.

Presentation of PUBG/DATE test system

Rohde and Schwarz presented the first system (digital station) of an order by PANAVIA comprising four Depot Automatic Test Equipment (DATE) stations and one programming station for the Maintenance echelon 4 of TORNADO avionics. This presentation took place in the presence of officials from the Federal Ministry of Defence, the BWB and the armed forces.

The automatic test system developed by Rohde & Schwarz is not only to be used for the TORNADO project, but also as an ATE for subassemblies throughout army, air force and navy.

First TADS/PNVS delivered

The first TADS/PNVS (Target Acquisition and Detection Sight/Pilot Night-Vision Sensor) system was delivered to the US Army by Martin Marietta Orlando Aerospace on July 30.

This first TADS/PNVS will be used for system integration testing at the Hughes production facility. Rollout of the first production APACHE is planned for September 30 at Mesa.

TADS/PNVS provides the APACHE with the capability to fly and fight around the clock in conditions previously considered impossible for flight operations. The system incorporates a combination of television, infrared, laser, and precision optics that allows the two man crew to navigate at high speed close to the earth in darkness and bad weather and find and attack tactical ground targets.

Martin Marietta's first year production contract covers 13 units, two of which will be used for trainers. Second-year production calls for 52 units, with four reserved for training. Present Army plans call for the procurement of 521 APACHES, with production extending into the late 1980s.

A small, economical, high performance speech scrambling system

For use in all types of radio communication networks has been developed by TE KA DE Fernmeldeanlagen, Germany, a division of Philips Kommunikations Industrie AG. The basic functional units are a pseudo-random generator, a central processing unit, synchronisation, storing and, for enhanced security a spectrum manipulating unit.

The pseudo-random generator forms a sequence length of thousands of billions of years at a bit-rate of 40 milliseconds. Its output is applied to the storing unit, where the digitalised speech will be stored in individual segments for different time intervals.

For synchronisation a phase reference signal is added to the speech signal. Once synchronised, interruption of the transmitting channel of up to 15 minutes will be tolerated without loss of synchronisation.

Switching the mode to "enhanced security", the spectrum manipulation unit will multiply scrambling codes by disrupting the spectral continuity on the transmitting path. Suitable algorithms will make the outgoing signal absolutely dissimilar to human speech whilst the original bandwidth of 0.3 to 3 kHz is still maintained.

HF communications network for NATO in operation

The 4th Tactical Allied Air Force put into operation recently its new automated HF communications network. The main contractor ANT Nachrichtentechnik, Germany (former AEG-Telefunken) has implemented this project within two and a half years, together with its subcontractors RACAL U.K. (HF-equipment) and Elekluft, Germany (shelter outfits). By means of this system the Headquarters 4.ATAF are provided with additional voice, data and telex links to the subordinate commands of the U.S., Canadian and German Air Forces.

The project comprises the supply of mobile and self-contained transmitting and receiving stations as well as mobile line-of-sight radio links to connect the HF stations to the HQ communications centre, whose equipment and outfit has been provided with a radio switchboard which allows the through-connection of all HF circuits to the telephone network.

The nerve system of the network is a processor-controlled remote control system type IFS8, which makes possible the control and monitoring at the HQ communications centre of all transmitting and receiving stations, all line-off-sight radio link stations including all ancilliary power aggregates and switching units. The stations are operated unattended and remotely controlled, changing the frequencies, operation modes, antenna directions etc., and may be performed within seconds by the HQ operator using Video Display Units (VDUs) of the central processor.

Already existing HF radio from other manufacturers have been interfaced additionally to the remote control system as well as to the HF switchboard, thus providing a fully integrated HF communications network for 4.ATAF.

Multi-Site Information System for the Electronic Security Command

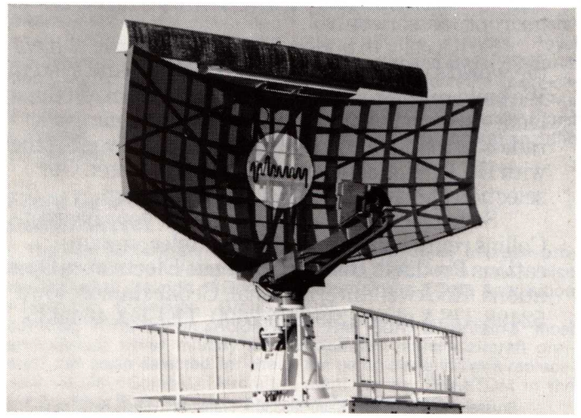
The U.S. Air Force Electronic Systems Command (USAFESC), San Antonio, Texas has awarded the Federal Systems Division of Wang a contract for worldwide delivery and installation of TEMPEST accredited, computer based information processing systems.

Under the terms of the contract, an initial order for 34 of Wang's 7500T Series of Office Information Systems (OIS) will be installed at 29 domestic and international USAFESC sites, and includes system configuration, technical support and training.

New Medium-Range Radar System for Finland

The advanced medium-range surveillance and approach control radar system WATCHMAN introduced by Plessey at Farnborough less than a year ago and recently selected by MoD as replacement radar for RAF airfields, has now been ordered by the Finnish Air Force.

Each (of three) installations will include the radar antenna with an on-mounted secondary radar antenna, signal processing equipment providing primary and secondary plot extraction, and three intelligent autonomous display consoles. The radars will provide flight control, terminal area and approach surveillance, GCA surveillance, approach control, radar sequencing control and outbound control at joint military/civil airfields. Deliveries will begin in 1985.



MILTECH INDUSTRIAL NEWS

Emergency One's TITAN II

Emergency One has introduced the TITAN II into its line of CFR firefighting equipment. It features an all wheel drive chassis and offers maximum manoeuverability both on and off the road. The all aluminium, maintenance free body houses the pump system as well as the water and foam tanks. The four man cab is constructed, out of marine grade aliminium alloy, so as to give maximum visibility. The water tank has a capacity of 1500 US gals and the foam tank 190 US gals. The pump system can be driven by either a power divider, PTO, or a separate pump engine.

Because the TITAN has a very low profile — and hence low centre of gravity — it has great stability and allows greater control. It has a Detroit diesel engine which gives it a top speed of 104 kph and an acceleration of 0-80 kph in less than 25 secs.

The TITAN II is designed with all FAA, ICAO and NFPA regulations in mind.

Messrs. Kärcher increase their domestic and foreign trade

1982 saw an increase in turnover of 37% which was achieved in both domestic and foreign markets. Supplies of high pressure steam jet cleaners to the German Bundeswehr, the French Forces and the US Army were the most important items.

In addition some bulk orders were made by countries in the Near East and Asia, and included special kits for tank degassing, steaming out ammunition, cleaning and preservation of aircraft and decontamination of personnel.

The first half of 1983 saw the first order from Italy for high pressure steam cleaners, tank degassing kits and kits to steam out ammunition, so Italy joins the 30 armies throughout the free world who rely on Kärcher steam cleaners to assure its materiel maintenance and increase its combat readiness.

As well as supplying products to land based forces Kärcher has also supplied cleaning and preservation kits for the AWACs, and aircraft cleaning agents to some NATO countries.

To be able to meet the extensive military and civil protection demands, and to be able to offer optimum solutions of problems, the staff of technicians (Dep. VSK) has been doubled in 1982/83. This positive development continues with a turnover increase of more than 50% in the first 6 months of 1983.

New Land Based Smoke and Decoy System from the UK

A new land based, passive area defence system was recently demonstrated in the UK to a large number of international experts.

The system is intended for the passive defence of airfields, missile sites, oil installations and power stations which are all very vulnerable to low level attacks by aircraft.

Known as RAMPART, it consists of three separate defensive systems.

(a) Radar and Infra-Red decoy rockets
(b) Screening smoke
(c) Kite balloons, known as Skysnares

All three systems are remote controlled by a VHF data link. Any or all of the systems can be selected by the radio operator to be launched.

In the demonstration, two RAF JAGUARs represented the enemy attacking aircraft. As soon as they were detected and it was obvious which target they were making for, in this case a dummy missile site, the various devices were operated one after the other from a central point. The radar and IR decoys are designed to upset the attackers' sensors, the smoke to prohibit visual attack and the tethered kite balloons to cause the attackers to make an extremely rapid ascent. They presented a physical barrier up to a height of 300 m. The rapid climb would prevent accurate weapon aiming and would also make the aircraft more vulnerable to ground defences.

The rockets, smoke and balloons were provided by Wallop Industries and the remote control system by Aish and Co — a newcomer to the defence field. They have recently merged with the Horstman Gear Group and are expanding fast. They specialise in computer assisted engineering and electronics generally and are particularly active in Australia and the Far East. Their new headquarters, co-sited with Horstman, was recently opened by the Secretary of State for Trade and Industry, Ceclil Parkinson M.P.

RAMPART has already been sold to a Middle East country and many other countries are showing considerable interest in it.

Training programmes in Nondestructive Testing (NDT)

Helling, one of the pioneers in the field of NDT, is today one of the leaders. Through the establishment of a modern well equipped training centre Helling can help the employer in training and the qualification of his technicians. Different types of courses are run which cater for the majority of needs; they include a basic course in radiography, eddy current testing, ultrasonics, radiation safety, management courses for those involved with NDT and the economics in the application of NDT methods.

Additional data about ARMBRUST P2

The following letter has been received from MBB Dynamics Division concerning the article "Cheap and effective: The new generation of Western anti-tank infantry weapons" published in issue number 3/83 of MILITARY TECHNOLOGY.

"In the above article, ARMBRUST and JUPITER are referred to in connection with a description of the advantages and disadvantages of the Davis Gun (countermass) principle, without mentioning that the special operational principle of both systems has virtually eliminated the disadvantages described.

In the case of the classical weapons following the Davis Gun principle, the front muzzle (not the warhead alone) must in fact be held outside the space in order to restrict the pressure within the confinement to that caused by the blast of the rear muzzle.

The closed system with pistons and brake rings, however, which permits neither flash, nor smoke or blast to leave the weapon at the time of firing, definitely makes it no longer necessary to hold the warhead outside the space to prevent high back pressure.

— It is correct that, after firing ARMBRUST or JUPITER, residual pressure remains trapped inside the tube. However, since piston and brake ring do not constitute a perfect seal, this pressure leaks off within a certain period of time. In addition to that, it has been proved in many trials that the pressurized launch tube does not blow up even if it is perforated by a stray bullet or a fragment.
— Damaged pistons in the tube can be avoided by 100% Xray inspections of the assembled weapon in addition to severe and continual inspections during production and assembly. All trials and qualification tests have shown that rough handling, transportation, and the specified storage conditions cannot cause damage or corrosion inside the tube. If outer parts are severely damaged, the tube should not be used as usual with any other weapon of that kind.
— The decision of the West German authorities not to take ARMBRUST into consideration for procurement is based on many other reasons than on objections to the weapon's function and performances.

Having made available to your readers the leading particulars of all systems except those of the ARMBRUST, here are some reference data of the ARMBRUST P2:

Caliber of warhead: 67 mm
Weight of projectile: 1.2 kg
Weight of complete weapon: 6.9 kg
Length of complete weapon: 920 mm
Combat range: 300 meters
Penetration performance: >400 mm
A subcaliber training device is available."

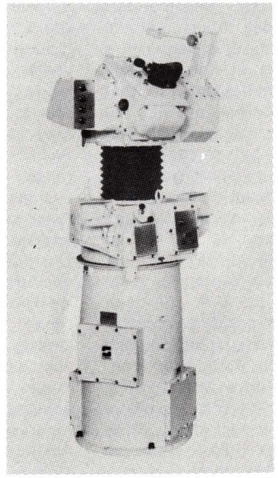
CSEE offers more than just TALISSI combat simulators

CSEE (Compagnie de Signaux et d'Enterprises Electriques) 17 place Etienne Pernet, 75738 Paris cedex 15, offers a variety of defence equipment in addition to the TALISSI family of combat simulators.

The LYNX optical sight enables anti-aircraft surveillance, optical target designation and control of one or more small calibre weapons. The optical sight is particularly suitable for defence of strategically important points, and can be located several hundred meters away from the weapons it controls. This sight equips ships of the French navy and is exported to several countries.

The mobile Telematic terminal is part of the SAPHIR data transmission network which permits police patrol cars to consult central data bases and exchange operational messages. The SAPHIR network consists of a radio and a telephone system which are connected. The terminal consists of a flat plasma screen and a keyboard which can be folded down onto the circuitry box. Two hundred of the 7,000 terminals ordered have been delivered to the French Gendarmerie.

The 2M TV Tracking System is associated with a standard television camera mounted on a rangefinder to permit automatic tracking of aerial targets. By means of contrast processing, the system provides measurements which give the position of the target in relation to the camera aiming line. Target lock-on can be automatic, semi-automatic, or manual. This system is the first result of military computerisation to CEN standards.



The LYNX optical sight.

The TALISSI systems simulate offensive and defensive combat under near-combat conditions. The systems are adaptable for anti-tank missiles (HOT helicopter, MILAN, etc.), for all types of tanks and for rifles. Firing is simulated by a low power laser. A computer gives instruction in relation to aiming accuracy and data displayed. A pyrotechnical system displays the fired shots and hits.

TALISSI is in service with the armies of Germany, Switzerland and the Netherlands. CSEE produces and markets the system under licence to the firm Kurt Eichweber, Hamburg.

Firing simulation with TALISSI.

New diving equipment for the Armed Forces of the Netherlands

In February 1982 the Dutch government established a new diving unit "The Underwater Reconnaissance Troop". All this is normal for a country that literally lives in the water. But what is remarkable is that the government has placed the safety of these divers in the hands of a relatively small and new, but highly specialized, firm: Aqua Services B.V. from Hardinxveld/Giessendam in Holland. Situated on the large waters south of Rotterdam, the firm has every opportunity to experiment and test. In a very short time it has made a name for itself in the areas of scuba, commercial equipment, oceanics, compressors and tools as well as in total diving systems.

Aqua Services conceived and manufactured a complete containerized air diving system for the government of the Netherlands. It is a lightweight and compact system. The decompression chamber is equipped with a complete depth conversion table with all necessary monitoring instruments.

The first three of these systems were delivered to the army of the Netherlands in 1982, and the company received a new order for 15 units for the navy of the Netherlands. The Egyptian navy also procures diving equipment from this firm.

Once again a close co-operation between civilian and military specialists, in this case between the Dutch diving school in Hedel and Aqua Services, has resulted in a product that is immediately operational and which conforms to the highest safety and quality requirements.

Further information can be obtained from Aqua Services B.V., Havenstraat, 6, P.O. Box 525, NL-3370 BA Hardinxveld/Giessendam, The Netherlands.

SMI introduces new AP ammunition

The Austrian company SMI (Südsteirische-Metallindustrie GmbH) has recently introduced a new 5.56 mm AP cartridge, compatible with all barrel twists from 7" to 12". This means that it can be fired from all existing or future 5.56 mm assault rifles, no matter whether they are rifled to the 12" twist (optimised for the old US M193 ammunition) or to the 7" twist (optimised for the new SS109/M855 NATO standard cartridge). The penetration capability of this new round is better than the NATO standard, being 15 mm mild steel min. at 100 m and 5 mm mild steel min. at 600 m; precision and other ballistic requirements are within the NATO requirements for M193 ball.

The obvious advantage of this new cartridge is the fact that armies already equipped with 5.56 mm assault rifles with 12" twist barrel (Colt M16A1, Beretta AR70, FAMAS, Heckler & Koch HK33 etc. etc.) will now be in a position to use an AP ammunition with performances even better than those of the new NATO standard round.

The new SMI bullet is very similar in shape to the SS109/M855, and weighs 4 gm; it is fired at a velocity of 948 m/sec. Its AP core is hardened steel and is positioned further forward than usual (with the consequent shift of the bullet's centre of gravity). This is the key feature allowing the round to be fired by 7", 9" and 12" twist barrels with no degradation in performance. The exact positioning of a very small AP core within the small 5.56 mm ball is a quite difficult affair, which doomed the US XM-777 bullet programme; it appears, however, that SMI has now found a way to handle this problem.

C-160s used for firefighting

Recently German Air Force pilots successfully demonstrated firefighting from the air using the C-160 TRANSALL. Two C-160s were equipped with a firefighting system developed by MBB in Hamburg. The system, strapped down in the TRANSALL's cargo hold, comprised a 13.8 m long cylinder containing 12,000 litres of fire extinguishing compound. These tanks can be emptied during low level flight in four to seven seconds. The spray is released due to both the built in slant of the system and by changing the aircraft's position, and thus increasing the angle of attack. During the demonstration the German Air Force pilots flew the two TRANSALLs in line at an altitude of 30 m. Each aircraft sprayed an area of 200 × 25 m with its extinguishing compounds, covering the pre-established target areas completely and easily.

A political decision has yet to be reached on whether the MBB extinguishing system in conjunction with the TRANSALL will be employed all over West Germany.

Defence seminar to be held in Pakistan

The Pakistan Ordnance Factories, one of the largest industrial combines in Pakistan, employing over 26,000 persons, is organising a defence seminar in Pakistan in November 1983. On the occasion of this seminar we shall be publishing an interview with the chairman of Pakistan Ordnance Factories in the November issue of MILITARY TECHNOLOGY (MILTECH 11/83), and this issue will also be distributed to all attendants. For further information please contact the Public Relations Department, Pakistan Ordnance Factories, Wah Camtt, Pakistan Telex 5840 POFACS.

Inside the Pentagon

President Reagan's decision to raise the military ante in Central America has bought a little more time for the United States to seek a political solution to the war-torn region. However, the ultimate political repercussions, both in the U.S. and internationally, will remain unclear for some time to come.

Diplomatic and Defense Department sources indicate that signals the U.S. is receiving from European governments are, for the most part, positive and reflect "an understanding" of U.S. objectives and how it is trying to achieve them.

While that may be true, some members of Washington's NATO-European diplomatic community privately express deep concern over the calculated sabre-rattling the President is using as a means to persuade warring factions to settle their differences at the bargaining table. "We hope America knows what it is doing in the steps it is taking," says one high-ranking official of one of America's closest allies. "We can't help but be nervous and are monitoring developments closely."

Mexico, which is finding it increasingly difficult to control its ire over America's "big stick" policy has this to say: "The U.S. (still) has an idea that it has a mission to defend the world from evil. Mexico doesn't necessarily recognize that mission."

Of course, the reason for America's sense of urgency in trying to arrest the regional turmoil is that it perceives a threat to vital American interests at its back doorstep, literally — in the form of a possible Soviet or Cuban operating base in Central America.

The threat of guerilla warfare expanding into a much broader conflict between the Cuban-backed government of Nicaragua and the U.S.-backed forces of Honduras, and the prospect of revolution spreading to neighboring countries undermines existing democracies in the area.

Also at work is deep American concern over its credibility among its NATO allies if, as one State Department official put it, "the United States failed to meet a commitment."

What this official is referring to is the Rio Treaty, also known as the InterAmerican Treaty of Reciprocal Assistance. Signed in 1947 by the U.S. and 21 other signatories in Latin America, the treaty established a mechanism for the countries to respond to armed aggression on a regional basis in the Americas. It has been invoked 17 times since 1947.

In its broadest sense, the treaty is viewed in Washington as a defense-diplomatic instrument parallel to NATO. Both involve long-standing friends. Both are concerned with the security of a major part of the world. And both carry expected obligations among sovereign nations. "I doubt that there are many in Europe who doubt our commitment to meet its obligations under NATO," says a senior Pentagon source. "But if the U.S. failed in a similar commitment we have in this hemisphere, there could be doubts about our resolve in other parts of the world as well."

Some European governments are taking a more active role in trying to bring an enduring peace to Central America. For example, reliable sources report that the Federal Republic of Germany is stepping up economic assistance to El Salvador and may soon place an ambassador in that country, which Germany has not had for some time. Further, the Spanish government has been working behind the scenes to help bridge communication gaps between opposing sides. Madrid's diplomatic assistance has been especially helpful, says a State Department official.

Pentagon sources emphatically state that "a combat deployment (in Central America) isn't in the cards" for the U.S.; the Joint Chiefs of Staff ruled that out as a precondition to approving the maneuvers now taking place in Central America. Rather, the maneuvers are intended to serve as a signal to Cuba and Nicaragua — and America's NATO allies — that it won't sit idly by while Cuba, and possibly the Soviets, exploit the already politically unstable region.

At the time of writing, two aircraft carrier groups sit off either side of the troubled isthmus. There is the USS RANGER plus seven support ships on the Pacific side, and the USS CORAL SEA plus four support ships on the Caribbean side. Between them, there are 140 combat aircraft and more than 13,000 U.S. servicemen. In addition, some 5,000 or so U.S. soldiers and Marines are scheduled to take part in combined air-ground exercises, mostly in neighboring Honduras. From the beginning, planning has been ragged and imprecise. Even the American public knew of the exercises and naval deployment before either the Defense or the State Department.

Much of the military operation, dubbed Big Pine II, will concentrate on schooling pro-Western forces in command, control, and communications; small-unit patrols; and the use of 105-mm howitzers. Roads will be paved, and airstrips built.

Depending on how much progress is made through diplomatic channels, and the flow of arms and munitions from Cuba to Nicaragua, a U.S. naval blockade can't be ruled out. It is no secret that American naval forces practiced interdiction techniques in August.

While a U.S. quarantine, or blockade, would have a devastating effect on Nicaragua — the U.S. remains its most important trading partner — America couldn't hope to enforce it indefinitely, say Pentagon sources. The United States simply doesn't have the surface ships to do so and still maintain a relatively high level of protection of vital interests elsewhere. Eventually, the U.S. Navy would have to pull back. Before that pullback occurred, however, the flow of arms into Nicaragua by boat would have been cut off for the time being.

Navy officials express little concern of being able to respond to an emergency in another part of the world as long as it keeps a major fighting force off the coasts of Central America. They argue that, short of war, the carrier battle groups could be quickly shifted to any place else where they could be more effective, and in any case, they are due to return to their regularly assigned areas "soon" — the RANGER in the Western Pacific and the CORAL SEA in the Mediterranean.

While major differences remain in Central America — between Nicaragua on one side, and Honduras, El Salvador, Guatemala, and Costa Rica on the other — there have been encouraging signs of progress in recent weeks. Examples: Special envoy Richard Stone is stimulating communications among the opposing sides. Nicaragua has signaled its willingness to participate in a multi-lateral dialogue. There is now reasonable hope that the Contadora group of Latin American countries outside Central America may be able to defuse the threat of warfare engulfing the whole region.

Officials in diplomatic and defense circles say that only partial credit for this progress can go to America flexing its military muscle, although no doubt it helped push the principals toward the negotiating table. Fact is a break in the diplomatic stalemate had already begun when the U.S. announced plans to demonstrate a show of military force in the area. Raising the military ante only reinforced what was already under way.

International diplomacy being what it is, the United States is being extremely guarded in how it describes unfolding events in Central America. Obviously increased pressure, in various forms, is being applied, but official Washington doesn't dare be so publicly, verbally blunt about it for fear that it could undermine its own behind-the-scenes peace initiatives.

It should be obvious by now that political change in Central America is inevitable, and it will continue to happen on a reoccurring basis just as surely as the major Western democracies experience periodic change, albeit much more benign, in the leadership of their own governments. Besides that fundamental recognition, it is important not to lose sight of the underlying causes of the trouble in Central America: Decades of political, social, and economic repression. The U.S. knows that.

The challenge in the months and years ahead will be balancing legitimate aid and guidance in improving the conditions that keep the region in a continuous explosive state, and the tendency to take too heavy a hand in the region's political evolution.

Tony Velocci

Ici Paris

The place of defence in the German budget no longer strikes the Germans as unusual, but is remarkable to the French. German taxpayers spend more on social benefits than on defence: this is what French newspapers wrote with a certain undertone of amazement.

The French would have every reason to focus on their own budget problems — defence hasn't been in first place in the French budget for a long time and the 133.2 billion Francs (3.95% of the GNP) in the 1983 budget fall considerably short of fulfulling the defence plans of the military.

To be sure, the restricted budget does have a positive effect on German-French joint projects: limited funds compel co-operation. This is one of the more salient reasons why the French are so interested in working together with the Germans. This was recently expressed by the Chief of Staff of the French Air Force, General Capillon, in a discussion with German partners, when he noted that the French were not at all in a position to carry out a programme such as the ACX alone. This is an experimental programme in which new technologies such as carbon fibres and CCV guidance are to be tested for a future combat aircraft.

Both sides have been racking their brains about a possible joint development of a fighter of the 90s for a number of months now. Basic papers pass back and forth across the border and all those involved hope to be able to produce a paper ready for signing when the Chiefs of Staff of both air forces meet in Germany on 25 October.

During his visit, General Capillon whishes to be informed by his "confrère" General Eimler about the principles of the air force deployment, logistics, the TORNADO programme and the ALPHA JET missions, especially about its anti-helicopter role.

The French general will certainly not miss the opportunity to again explain the French ideas about a fighter to his German counterpart. By the way, the French now call this project the "Avion de Combat Tactique", and it is designated with the year number 95, not number 90 as the German fighter. Aside from that, the concept doesn't necessarily prejudice the aircraft's mission. The French are assuming that the air-to-air mission in such a programme will "condition" the design of the aircraft. This pre-condition however would not necessarily exclude an air-to-ground role.

This means that the French Chief of Staff will try to convice his German partners that, simply due to the high costs alone, both air forces can no longer afford aircraft which can only fly in one role.

Someone who would like to have helped bring this programme costing billions to a joint successful conclusion, as he once did so substantially with the joint German/French aircraft, the ALPHA JET, must have left the French Air Force scene with a bit of wistfulness: the German Air Force attache in Paris, Colonel Hermann Fraidel, left France after three and a half years to become involved in plans and policy with the Second ATAF at Mönchengladbach. Including his studies at the Ecole Supérieure de Guerre Aérienne, and with a few interruptions, Hermann Fraidel served nine years in France. These many years of service certainly benefitted both sides. Not only did the ALPHA JET programme materialise during his time, but the foundation was laid for a continuing pilot exchange between the two air forces; furthermore, general staff meetings were initiated and, for the first time in nine years, a German Air Force Chief of Staff, General Obleser, was decorated with a French order.

The French Air Force attested to the contribution of the German Air Force attache at the embassy in Paris by awarding Colonel Fraidel the Medaille de l'Aéronautique, an event which takes place only rarely.

His successor, Colonel Weste, will not have it easy in following in the footsteps of his predecessor, whose farewell ceremony was attended by fifteen high-ranking Air Force generals.

Colonel Fraidel's chief at the embassy has also left: Defence Attache Admiral Hoffmann has retired. No Navy man will take his place in the future, since in the meantime the position of Defence Attache in London has been filled by the Navy. Hoffmann's successor is an Army general, von Wieterheim, who knows France, since he was already at the German Embassy in Paris many years ago.

Udo Philipp

The BMY plant which is sited some 70 miles north of Baltimore. The manufacturing facility occupies some one million square feet all under cover.

BMY: tracked artillery for the Free World

Bowen-McLaughlin-York or BMY as it is commonly known is a division of the Harsco Corporation. BMY is a manufacturer of tracked field artillery, recovery and resupply vehicles for the U.S. and much of the free world's countries. Besides manufacturing, BMY has the engineering capability to design, develop and test all related types of tracked combat vehicles. The company also has extensive experience in rebuilding, modification and conversion of existing military vehicles. BMY has undertaken many major research and development projects as a vehicle design agency for the U.S. Army and private contractors in the U.S. and abroad.

BMY currently manufactures M-109A2 SP 155mm Howitzer and the M88A1 Recovery Vehicle. It also produces the Field Artillery Ammunition Support Vehicle (FAASV) and its international market equivalent, M109 ADS (Ammunition Delivery System). Additionally, BMY undertakes the conversion and spare parts contracts with foreign governments for heavy military vehicle equipment.

BMY is located in 130 acres on the outskirts of York, Pennsylvania about 70 miles north of Baltimore, Maryland. The manufacturing facility has more than one million square feet under roof, which can be expanded. The plant contains an extensive quantity and variety of automatic, semi-automatic and hand tooling for metal working, welding, etc. for the manufacture of combat vehicles.

In addition to its major military customers, BMY has also produced hydraulic presses, 50 ton capacity truck bodies, the chassis for aircraft boarding vehicles, hydraulic impact wrenches, grinders and tools that are used under water by off shore oil drillers.

The Harsco Corporation, BMY's parent company conducts its business through 16 divisions, has 22 varied classes of products and services. Its operations fall into four major industry segments; primary metals, fabricated metals, construction and defense. In 1982, Harsco's net sales were just under one billion dollars. BMY's portion was just under one third of that total.

Major products

M-109: The M109A2 155mm Self Propelled Howitzer has been in production at BMY since 1974. The product has undergone constant product improvement engineering. That refinement continues as BMY defense engineering teams with other weapons professionals integrate advanced technologies and subsystems into the classic M109 envelope.

The M 109 155 mm SPH which has been produced by BMY since 1973. The company is currently involved with the Howitzer Improvement Programme along with Honeywell, Emerson, SAI and Phoenix Engineering.

The FAASV shown in the "prime mover" mode in support of the M198 towed howitzer.

M109A2 Specifications:

General	
Crew	6
Weight, combat loaded	55,000 lbs (24,948 kg)
Length	359 inches (9.12 m)
Width	244 inches (6.19 m)
Height	124 inches (3.1 m)
Ground clearance	18 inches (0.45 m)
Shipping volume	2250 cu. ft. (63.7 cu m)
High speed	35 mph (56.3 kph)
Maximum grade	60%
Maximum trench	72 inches (1.83 m)
Maximum vertical wall	21 inches (0.53 m)
Turn radius	one vehicle length
Cruising range	217 miles (349 km)

Armament and Ammunition
One Howitzer, 155 mm, M185 (34 conventional rounds, two COPPERHEADs); One .50 caliber Machine gun, M2 HB Flex; Six rifles, 5.56 mm, M16A1; Twelve hand grenades

The M109A2 SPH is a full track, armored vehicle with all terrain mobility and speed. The hull is aluminium armored with a 360 degree turret. The power plant is a 405 hp (302 kW) Detroit Diesel 8V71T two cycle turbocharged engine. The transmission is a GM, Allison XTG-411-2A with four forward and two reverse speeds. The main armament consists of the 155mm howitzer capable of firing all current HE, AT, submunition, rocket assisted and guided projectile rounds. A mount is provided for any type of machine gun. The mobile gun platform carries 34 rounds as well as two COPPERHEADs.

FAASV: The U.S. Army has classified the new Field Artillery Ammunition Support Vehicle (FASSV) as the M992. Sharing the same combat proven chassis and drive train as the M109A2, the M992 provides: automated ammunition conveying system; increased ammunition payload capacity; armor protected fusing and round preparation area; APU that supports both howitzer and ammunition vehicle; prime

To the left is shown the M 109 of which BMY manufacture 75%. As a vehicle manufacturer and systems integrator company BMY is exploring licensing opportunities with proven and availlable foreign developed weapon systems. Below is the M 88A1, a heavy recovery vehicle.

FAASV Specifications:

Ammunition Capacities (maximum, stowed)
Net ammunition payload: 12,000 lbs (5425 kg)

	Projectiles	Propellant	Fuses
155 mm	93	99	104
175 mm	86	87	104
203 mm	48	53	56

General

Vehicle weight, combat loaded	57,500 lbs	(26,150 kg)
Length	267 inches	(6.78 m)
Width	124 inches	(3.15 m)
Height	126 inches	(3.20 m)
Speed-level	35 mph	(57.7 kmh)
Speed-10% grade	12 mph	(20 kmh)
Range at 41 kph	360 km	

M88A1 Specifications

Weight, combat loaded	112,000 lbs	(50,803 kg)
Length, boom stowed	325.5 inches	(8.27 m)
Width, at track	135 inches	(3.43 m)
Height, boom stowed	123 inches	(3.12 m)
Crew	4	
Maximum speed	26 mph	(42 kmh)
Cruising range	300 miles	(483 km)
Grade, without load	60%	
Vertical obstacle	42 inches	(1.07 m)
Trench width	103 inches	(2.61 m)
Water fording	56 inches	(1.42)

Armament and ammunition
.50 caliber Machine gun M2HB Flex, 1500 rounds
Two caliber .45 submachineguns, M3A1, 360 rounds
Two 5.56mm M16 or 7,62mm M14, 300 rounds
M72 LAW rocket with launcher, 10 rounds. Hand grenades, eight.

mover potential for any type or towed howitzer.

M88A1: The M88A1 is a full track, diesel powered armored recovery vehicle. Weighing 110,000 lbs, its primary mission is to recover disabled main battle tanks of the M-1 and M-60 series. The recovery vehicle features a hydraulically operated spade, boom, main winch, hoist winch, impact wrench and refuel/defuel pump. It is powered by the same engine used to run the M-60 main battle tank.

BMY originally designed the M88 as a gasoline powered vehicle and built more than 1,000 up to 1964. The diesel configuration (A1) has been produced since 1975. All gasoline models were reconfigured to diesel by BMY.

Drawbar pull of the M88A1 is 90,000 lbs; main winch pull is also 90,000 lbs; boom capacity is 50,000 lbs; hoist winch lift is also 50,000 lbs. The vehicle operates on an auxiliary power system powered by a 10.8 hp diesel engine. The M88A1 has been type classified by the U.S. Army for use through the 1990s.

Family of Vehicles: (M110, M107, M578). The "Family" consists of four vehicles that have commonality of parts of the hull assembly, power plant, vehicle control, fire control and a similarity of other installations. For the most part, these vehicles are no longer in production at BMY. However, the production lines can be restarted within a short period of time depending on orders from the U.S. or other countries.

The vehicles are full tracked. They are:
M107 Self Propelled Gun
M110 Self Propelled Howitzer
M110A2 Self Propelled Howitzer
M578 Recovery Vehicle

The M107 175mm gun and the M110 (A2) 203mm howitzer have good mobility and are air transportable. They weigh about 60,000 lbs. The vehicles are identical except for the cannon and the fire control equipment.

The M578 is a light recovery vehicle (54,000 lbs), diesel powered with a 30,000 lbs boom winch and a 60,000 tow winch mounted in an armored cab. Maximum hoisting capacity is 30,000 lbs.

Research and Development

BMY during 1983, will nearly double its engineering and business development capabilities. The company is currently involved in fourteen major new development programs and twelve minor programs. The major programs are those which could result in production contracts worth more than 100 million dollars if and when BMY wins production bids. Seven of the programs involve significant new technologies in materials and production methods. The programs will serve both the U.S. and foreign markets.

Another derivative of the M109 is the CPV for command post vehicle. It is currently part of a test bed program with the U.S. Army to incorporate a life support system that resists NBC warfare. BMY is in the advanced development stage for design of two test beds for a counterobstacle vehicle or COV. This is an M88 derivative. The COV has mine plows, bulldozer blades and telescopic arms.

The company is participating as prime contractor with Honeywell, Emerson, SAI and Phoenix Engineering in the recently announced M109 Howitzer Improvement Program (HIP). They are also participating in the development of the LVTX amphibious assault vehicle development program for the U.S. Marine Corps. The company is engaged in development of a heavy assault bridge to be built on the M-1 battle tank chassis. Finally, product improvement kits are being designed for the M88 family of vehicles.

BMY is cooperating with General Dynamics Corporation on the GD Air Defense Gun System (ADGS). BMY will provide the M109 chassis and turret for the system. General Dynamics will market the mobile air defense system to free world countries in the near future.

Above: the FAASV was recently type classified as the M992. It's on contract now for initial delivery to the US Army in late 1984. Below is the BMY Command Post Vehicle designated FDCV/CPV.

"The aim is to mature into a prominent defense developer..."

Interview with Mr. Vincent L. Jones, President of BMY

MT: *Mr. Jones, briefly tell us how BMY began and how it has grown through the years?*
Jones: BMY derived from the founders' names, Bowen and McLaughlin, contractors who during WW II had a significant history with the military developing highways and runways in remote places. Because equipment was hard to come by, Bowen and McLaughlin ended up having to rebuild most of their construction equipment. As the war came to a close the military had armored equipment that they wanted to refurbish and make available for continued lend lease programs. The Army invited Bowen and McLaughlin to get involved in the rebuilding of that equipment. They rebuilt many WW II tanks and halftracks. The company, therefore, was founded as a rebuild/remanufacturing house. in 1967 the Harsco Corporation purchased Bowen-McLaughin.

The president of BMY, Vincent L. Jones (on the right) being interviewed by Military Technology's Ron Sherman.

MT: *What are the principle products that BMY now manufactures for the U.S. Department of Defense and foreign governments?*
Jones: Our principal products are the M109 and its derivative vehicles, the M88, medium recovery vehicle (the biggest recovery vehicle in the world, used by most of the Free World), and the so called family of vehicles — the M578 light recovery vehicle, the M107 175 mm gun vehicle, and the M110 203 mm or 8" self-propelled howitzer — they are all built on a common chassis.

MT: *What is included in the M109 family?*
Jones: The M109 family includes the A1B and the A2 howitzer and we have the logistics vehicle which is currently type classified in the ammunition version — the M992 for the U.S. Army which is equipped to carry ammunition as resupply for the M109 155 mm howitzer. The Army will be type classifying it in the 8" howitzer version also as an ammunition support vehicle.

MT: *What is the gross income picture for BMY... the projected growth rate?*
Jones: In the next two years sales will be right around the 250 to 300 million dollar mark.

MT: *How much of this approximately 300 million a year business will be outside of the U.S.?*
Jones: About one half to two thirds will be to other than the U.S. Army.

MT: *In the off shore sales efforts, how much of this is FMS versus direct sales?*
Jones: It runs about half also. Pure FMS sales are dropping off in favor of direct sales.

MT: *Why is that?*
Jones: In my experience, countries seem to prefer dealing with contractors directly rather than through the government as a middleman. I would like to think that BMY is more responsive to the customers' needs in the areas of changes, timeliness of delivery and price. I also believe that we in industry can provide more imaginative contractual arrangements than are available through FMS channels. This is not to say that American industry can go it alone. We need the support of our legislators and the Departments of State and Defense to be successful.

MT: *What about product maintenance and training for your international clients?*
Jones: We have long been involved in the training and maintenance area through our "tech rep" program which we believe is among the best in the field. We are also deeply involved in ILS planning and programming for the U.S. Army. Certainly, these capabilities must be tailored and we are taking steps to do this but the foundation is there.

MT: *BMY has not been known for its development activities. Recently, this has been changing. Tell me about your research and development activities.*

The proven team concept, featuring the Fire Artillery Ammunition Support Vehicle (FAASV) and the M109A2 155 mm SPH.

BMY R&D engineers check out some recent modifications to the CPV prototype. The CPV is a joint BMY, Human Engineering Laboratory (HEL), Aberdeen Proving Ground programme. The interior of the vehicle can be configured to meet a variety of battlefield requirements.

Machining of the M88A1 hull. To manufacture one M88A1 Recovery Vehicle requires 35,000 lbs of armoured casting. BMY designed the M88 in 1955 and has produced it as a sole source since 1960.

Jones: Our last significant order for howitzers from the U.S. government was March 1980. To stay viable the company must have more products and more customers. Our main effort was to sell more of what we had. That caused us to develop our international sales capability. The second effort was to derive other vehicles from what we have. The M992 is an example of this. The third is to develop new products which caused us to expand our activities into the R&D area. There are two ways to do that: one is to compete for new programs and the other is to anticipate the needs of the market and enter into in-house development programs to support these needs.

MT: *What was the major problem you faced in building an R&D program?*
Jones: Perhaps the biggest problem we had was limiting our appetite. When we made a business development assessment we found the menu to be very large. We, therefore, had to weigh each opportunity very carefully and make some deliberate decisions as to which ones we should pursue. We have found that it is tough to change people's perceptions about your capabilities. Trying to take on too many programs would have been an invitation to problems which would have reinforced the doubters' opinions that we cannot change our spots. I believe we have surprised a few folk and in large measure our success is due to the approach we took determining in which games we would play.

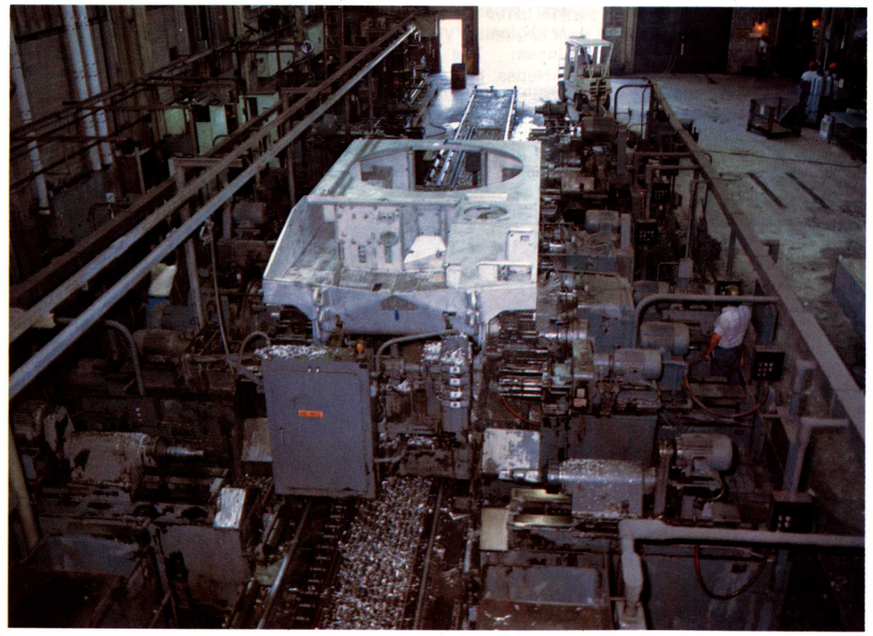
MT: *What specific products are in development right now?*
Jones: We are developing a Counter Obstacle Vehicle for the combat engineers and we have recently won a development contract for the Heavy Assault Bridge. Those are the two major programs. We have a number of others. Half of these are funded by the government and the other half are funded by BMY.

MT: *You mentioned that some of the production programs are involved in cooperation agreements. Could your tell us about those?*
Jones: We can no longer expect other governments to export their jobs by buying their products here in the U.S. The philosophy that our industry has followed in the past few years has, in fact, driven many of these countries to become competitors. Had we been willing to work with them on a co-production basis they would not have invested their R&D money and we would not find so many competitive products in the world marketplace. I decided that, as a policy issue, any country willing to co-produce on a 50/50 basis is worth cultivating. This at least gets us into the marketplace.

MT: *Can you name specifically some of the licensing and co-production programs that you now have working or are working towards?*

Jones: Well, the Heavy Assault Bridge program involves an Israeli bridge to be married to a launcher that is designed by our engineers for installation on the M1 tank. We also began with a co-production agreement in Belgium. Their half of that plan became too costly and they reverted to giving us the prime contract with offsets. We have a co-production contract for the Clear Lane Marker System that IMI devised and the U.S. government has some interest in.

Overview of the Cross Transformation Multiple Machining Center that performs about 213 seperate machining operations on the aluminium hull of the M109 chassis. BMY has produced nearly 2,300 M109s since 1973.



MT: *And that is mostly co-production? That is, no licensing, or does that include licensing?*
Jones: We will go either way depending on what the partner prefers. If it is a developer usually he wants the license. If it is a country who develops for a manufacturer opportunity he wants to co-produce.

MT: *Now what we would like to do is discuss the improvements that BMY is building into the old M109 SP howitzer.*
Jones: The M109 is viewed by many as an obsolete platform for three reasons: rate of fire, range, and the lack of electronics. Some believe that the M109 could never be product improved to deal with all those issues. Our aim is to retain the reliability of maintainability reputation of the M109 and still come up with the answers to the rate of fire and the range question. For range, we believe a longer tube is the answer. The technology is proven so this should be a relatively low risk mod. To achieve speed, we believe a semi-automatic loader can permit a firing rate of up to eight rounds in about 40 seconds, which seems to be consistent with the Army's requirement. There is a lot that can be done electronically to enhance the responsiveness and survivability of the M109 that uses today's technology and we are prepared to provide as much in this area as the customer wants.

MT: *Your presentation to improve the M109 is obviously in cooperation with several other companies?*
Jones: Yes, we made a conscious decision against vertically integrating our engineering house. We chose instead the approach of teaming with those companies whom we felt would provide the best overall capability to respond effectively. For the M109 upgrade we have teamed with Honeywell who will do the electronics; Emerson is handling the loader, Phoenix Engineering for the cannon and breech technology.

MT: *In that same context, can you talk a bit more about the major technology advances you see in track vehicles in the future?*
Jones: In track vehicles the new technology is going to be composite materials of some sort. We hear a lot about Kevlar and there are other types of composites that are being developed. There will be some kind of composite material technology to replace or supplement metals. The trade also talks about electro-magnetic propellant systems or liquid propellant systems for the next generation of artillery. We are not presently directly engaged in the development of this technology.

MT: *But you are going to retain interest even in the future as far as integration of systems, are you not?*
Jones: As I said, we expect to integrate this new technology into new systems. Whatever the scientists create to put steel and explosives through the air is going to be integrated into a weapons system and we expect to do that whether it be a tracked system or a wheeled system.

MT: *Speaking of the future, again, what do you see as possible product lines for BMY now that the company is beginning to branch out?*
Jones: We are presently actively competing for a number of new product lines, most of which are combat vehicle associated. In the future we hope to expand beyond the combat vehicle line.

MT: *BMY was also involved in retrofitting or overhauling old armored vehicles. What about this business, what is the status of it?*
Jones: Dead, but hopefully not yet buried. The vast majority of this business in the past was done by government depots. carry such a burden. We will continue to work through our International Distributor and his in-country representatives.

MT: *What about the physical plant. Are there any on-going or future plans to improve your plant facilities?*
Jones: We have done a lot of things to improve productivity, but we must do more. I perceive the recent recession as having created a real technology revolution and I think we will look back on this, not very many years hence, as being every bit as much a revolution as the industrial revolution. The technology revolution is going to bury a lot of us if we do not stand up and get to work.

MT: *Is there anything that you would like to comment on that we have not covered?*
Jones: A key objective at BMY is to mature into a prominent international defense developer, manufacturer and co-producer of land warfare systems. Most folks in our business throughout the free world are quite nationalistic. There is an opportunity for someone to become identified in the free world as capable, honest, fair, easy to do business with and who will "be there" in the years to come. I intend for BMY to gain that reputation in the Internationally, most countries tend to embrace the U.S. system. We have demonstrated that we can do an overhaul/rebuild job equal to or better than the depots as far as quality at a cheaper price. We did this with tanks, wheeled vehicles and the U.S. Army's entire M88 gasoline fleet.

MT: *Do you have an international distributor?*
Jones: We have contracted with an international distributor who has access to the world markets and whom we have licensed to use our name. They present themselves internationally as "BMY International". They increase the size of our marketing force considerably and gives us added flexibility in working in the international marketplace.

MT: *Are you building an international sales bureau?*
Jones: No, we are not ready to driven this country into a productivity stampede which has world's defense marketplace. That is our goal.

A BMY engineer works out a design problem on one of the company's two CAD/CAM systems which support operations in both design engineering and manufacturing.

This industrial portrait was prepared in cooperation between BMY and Mönch Media US Inc.

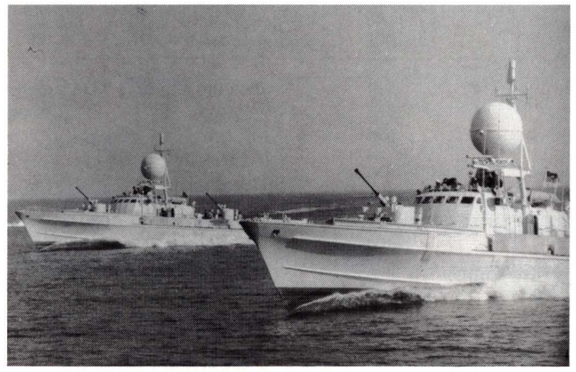
MILTECH NEWS

Military Technology · Issue 10 · Oct. 1983 · Vol. VII

Americans and Greeks come to an agreement

An agreement has been reached on the future of American bases in Greece, at least for the next five years, by which time the Papandreou Government may no longer be in power. Greece claims that all her demands — including the right to control their activities, an expiry date for the agreement, extra territorial rights for American soldiers to be abolished, the ratio of 7 (Greece) to 10 (Turkey) in military aid to be maintained and that the bases would only be used in a defensive role — have been met. American sources are simply saying that they are glad that an agreement has been reached, that the expiry date is 31 December 1988 and that the bases will then be dismantled over a 17 month period. One aspect of the agreement which is not clear is whether the Greek Government has any intention of terminating the agreement early, which it has the right to do, and thus honour its promise to the Greek people to "kick the Americans out of the country".

Second-hand German ships for Turkey



The German frigate KARLSRUHE, recently transferred to the Turkish Navy and renamed GAZI OSMAN PASHA (see MT 6/83 page 132) is to be followed by other naval vessels, to be decommissioned by the German Navy in the near future.

On September 29, the Turkish Navy will officially receive the frigate EMDEN, sistership of KARLSRUHE. In the subsequent months, the transfer will be arranged of seven of the torpedo FACs of the ZOBEL class, now completely replaced by missile-armed units.

Egypt signs deal with Romania

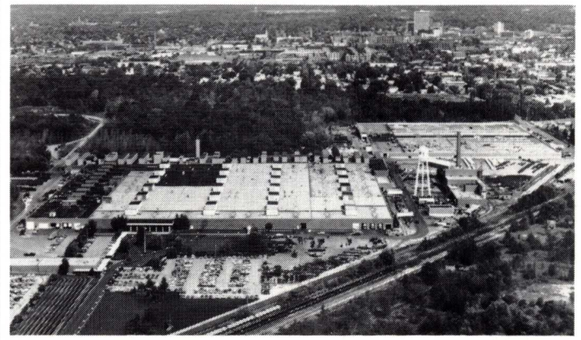
The Egyptian Ministry of Defence officially announced that an agreement was reached with Romania for technical assistance and co-operation in the production in Egypt of a Main Battle Tank as well as of spare parts for some weapon and electronics systems.

Egypt will produce, at the plants near Cairo, the Romanian TR-77 tank. This is a modified version of the Soviet T-54/55, several hundreds of which have already been produced in Romania by conversion of the existing T-54/55s: main modifications are different running gear with six road wheels as opposed to five and the addition of side skirts. It also appears very likely that the Egyptian TR-77s will not be new vehicles, but converted T-54/55s: Egypt still has about 1,250 T-54/55s, although some of these are being converted with the L7/M68 105 mm gun and with a new power pack.

It is still not clear whether the decision to produce the TR-77 means abandoning the former, and far more ambitious, Egyptian plan to start production of a modern MBT towards 1984-85, in co-operation with either Great Britain or France (see MT 3/83 page 85). In theory the two programmes could well run in parallel, but in practice it appears rather unlikely that Egypt has both the industrial and — mainly — the financial capability to handle both conversion of its T-54/55s to TR-77 standard and production of a modern MBT (either CHIEFTAIN 900/CHALLENGER or AMX-32/AMX-40) at the same time.

Perhaps even more important for Egypt is the agreement about joint production of spare parts for Soviet military equipment. Soviet-manufactured equipment still represent quite a substantial part of the Egyptian arsenal, and they are rapidly becoming unserviceable for lack of spare parts: this has led Egypt on the one hand to try to modify Soviet systems with Western components (a process which, however, cannot be extended to all the systems in service for financial reasons) and on the other to a large-scale "cannibalisation" process which has led to a nearly frantic search for Soviet spare parts whenever available. The agreement with Romania should now largely solve the problem.

LTV purchases AM General Corporation



On July 25, LTV Corporation announced that it has reached an agreement with American Motors Corporation for purchase of all the operating assets and business of AM General Corporation. The cost of the takeover is being put at about $ 170 million, comprised of $ 220 million in cash and the balance in short-term notes.

AM General, the largest US supplier of tactical military vehicles, was a highly successful subsidiary of American Motors Corporation; last year, the company registered sales of 485 million with about 2,600 employees. Readers will also recall that AM General recently won the US Army HMMWV competition with its HUMMER, and has received a five year $1.2 billion contract for the delivery of 54,973 HUMMERs.

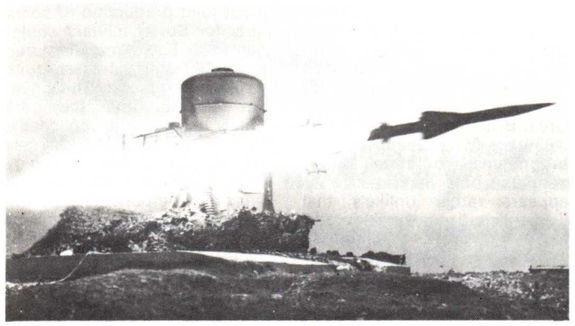
The acquisition of AM General by LTV is strikingly similar to the former takeover of Chrysler Corp.'s Defense Group by General Dynamics: in both cases, an automotive company in financial difficulties was compelled to sell its valuable defence assets to an aerospace company.

AM General will now be operated as part of LTV's aerospace/defense group. LTV Corp., which two years ago failed in its bid to gain control of Grumman, is also aiming at taking over Sierra Research Corp. (an electronics avionics firm).

Independent testing raises its head once again

A new office, similar to the one that existed in the Carter Government, was approved by the Senate. This office would have the power to prescribe policies and procedures for testing new weapon systems. At present the personnel who set up and monitor test programmes are the very people who are in charge of pushing those programmes inside the Pentagon. Therefore stories have emerged of pilots being briefed beforehand on the situations they were going to meet, breakdowns ignored – the parts were called non-chargeable, and equipment not being tested in the sort of environment it would find itself working. There *is* somebody in the Pentagon who is responsible for running tests and reporting the results — but — his boss is responsible for pushing the very weapon systems that are tested.

Is the new office going to be given a chance to succeed? the opportunity for bureaucratic bargaining remains and it will be up to the watchdogs to bark if they become suspicious otherwise they could find that independent testing is once again a non starter.



Turkey adopts RAPIER

The Turkish Army has placed an order for an unspecified number of BAe Dynamics RAPIER surface-to-air missile system (in the towed configuration), together with the associated BLINDFIRE radars for all weather tracking. Reliable sources report that the order is worth about 150 million pounds, and is for 36 units.

Turkey is the 12th known customer of RAPIER, and the third one within NATO; the system is in service with, or being delivered to, Abu Dhabi, Australia, Brunei, Great Britain, Iran, Oman, Qatar, Switzerland, Singapore and the USAF forces in Europe.

The deal has been surrounded with a veil of secrecy quite uncommon for sales within NATO, and BAe will not deny or confirm that a contract has been signed. This appears to be linked to the peculiar commercial moves which have led to the sale: the US had a long-standing programme to supply Turkey with Euromissile ROLAND systems, to be purchased by the US Government and then channelled to Turkey through FMS. But while this project was being discussed, BAe was able to take the short cut and clinch the deal.

Would you like to buy Hughes Helicopters?

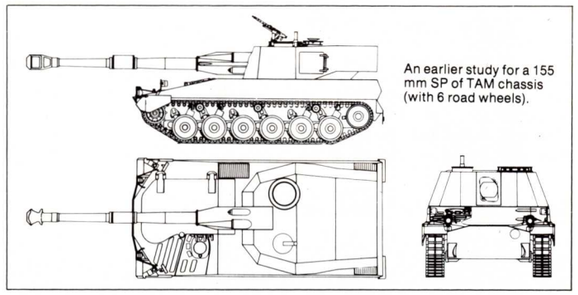
It does not happen very often that a company is offered for sale which not only is in good financial health — turnover for 1983 should be around $ 600 million, with a 30% increase foreseen for 1984 — but also enjoys brilliant prospects for the future (firm orders for more than $ 1.5 billion are presently in hand). And yet, this is exactly what is happening with Hughes Helicopters: the company has been put up for sale by the Hughes Estate, for a minimum price of $500 million (which could still be considered a bargain).

The decision to sell Hughes Helicopters is a direct result of the nearly inextricable financial nightmare resulting from the death of the late Howard Hughes (who died intestate) on the one side, and of the IRS' attitude on the other. Hughes Helicopters will need investments exceeding $ 150 million in the near future — mainly in relation to the LHX programme — and the Hughes Estate, which is facing claims for inheritance taxes for more than 75% of its total assets, is badly in need of cash, and cannot provide this money.

155 mm SP howitzer on TAM chassis

Apparently at the request of the Argentinians, OTO Melara of Italy is studing the possibility of fitting the turret of its PALMARIA self-propelled gun/howitzer (armed with a 155/41 mm weapon developed by OTO Melara itself) on the chassis of the TAM (Tanque Argentino Mediano) light tank.

Mechanical integration should be performed, if the study proves the feasibility of the concept, by Thyssen Henschel in Kassel. The TAM chassis will have to be lengthened (with seven road wheels instead of six) and widened in order to accommodate the PALMARIA turret, the combat weight will be pushed up to 45 t (for comparison, the PALMARIA — which utilises an OF-40 MBT chassis — weighs 46 t in combat order, while the standard TAM weighs 30.5 t).



An earlier study for a 155 mm SP of TAM chassis (with 6 road wheels).

ALMIRANTE GRAU to be refitted

The Peruvian cruiser ALMIRANTE GRAU (ex-DE RUYTER of the Royal Netherlands Navy) will be completely modernised and refitted by Dutch companies under a HFl 350 million contract. Main contractors are the ADM ship repair yard in Amsterdam and Hollandse Signaal.

No details about the modernisation programme have been released so far, apart from the fact that ALMIRANTE GRAU is to receive a new combat information system and new FCSs; there are also rumours that she will be fitted with the Lightweight SEAWOLF VM.40 antimissile missile system. If confirmed, this will be the first order for the SEAWOLF VM.40.

The contract for the refitting of the ALMIRANTE GRAU is actually only the tip of an iceberg: ADM and Hollandse Signaal, in fact, now appear to be very well placed to win the contracts for a similar modernisation of all the seven ex-Dutch destroyers of the FRIESLAND class purchased second-hand by the Peruvian Navy in 1980-82. Total value of these follow-on contracts is expected to be in the region of HFl 1 billion.

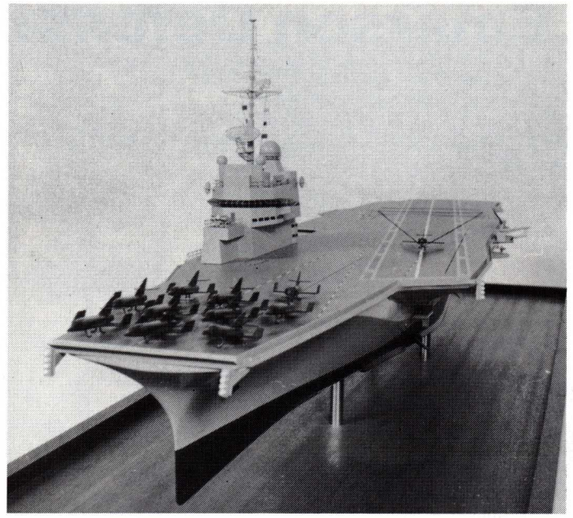
First details of the new French carrier

DTCN has circulated the first information about the new carrier for the French Navy, bearing the temporary designation of PAN (Porte-Avions Núcleaire, Nuclear Aircraft Carrier) and intended to replace the CLEMENCEAU towards 1996. The carrier, included in the 1984-1988 defence programme, will be ordered in 1986 and laid down in 1988 at the Naval Arsenal at Brest; a second unit to replace the FOCH is also tentatively planned at a later date, although still without official blessing.

The PAN will have a full load displacement of about 36,000 t, a wl length of 238 m and a wl breadth of 31.8 m: she will be constructed much along the lines of her 32,700 t predecessors of the CLEMENCEAU class — an interesting attempt to design a carrier of rather contained dimensions but still able to operate with CTOL (as opposed to V/STOL) aircraft. It is however to be pointed out that the hull's dimensions were limited *a priori* by the necessity to take into account the dimensions of the naval drydocks at Brest and Toulon. In practice, the main design problem was how to ensure, within acceptable dimensions, sufficient space for the flight component.

The nuclear power plant will be based on two nuclear reactors of the same model presently being developed for the seventh SSBN; it will develop more than 80,000 hp, giving a max. speed of slightly over 27 knots. If confirmed, this data could be considered as rather surprising when compared with the 126,000 hp and 32 knots of the CLEMENCEAU's steam turbines power plant.

The general configuration of the new carrier, although still "classical" in general outline, will be rather innovative from some points of view — such as, for instance, the island placed forward instead of midships or aft as in the most recent US carriers. This solution was adopted in order to leave space for the two lifts (20 x 12.5 m, capacity 50 t) arranged one behind the other on the right side. Between the two lifts, a large space for parking is available: this space, whose lack has been identified as one of the most serious shortcomings of the CLEMENCEAU's design, will allow a number of aircraft to be kept ready on alert without interfering with the normal flight operations. Also, with both lifts placed abaft the island and hence shielded by it, it is possible to reduce the adverse effect of heavy seas on the fore lift. In order to facilitate movements between the hangar and the flight deck, the two lifts can each carry two aircraft at the same time.



A model of the future French nuclear-propelled carrier. She will bear the name of CHARLES DE GAULLE. Notice the island positioned far further forward than usual.

In order to maximise the space available for the aircraft and the related workshops, the PAN has been designed according to the "open hangar" principle, with the hangar taking the whole width of the ship. This choice was also influenced by the desire to have lateral lifts, preferred to axial lifts for their obvious advantages (no interruption in flight operations when the lifts are lowered, less risk of a fire on the flight deck reaching the hangar, easy adaptation to new aircraft).

However, in order to combine the "open hangar" principle with a sufficient structural strength the hangar is not placed immediately under the flight deck, but is separated from the flight deck by an intermediate deck. As a result, the hangar will be larger than that of the CLEMENCEAU (ratio 1.4:1) with dimensions of about 140 x 30 m, but its height will be reduced.

The flight deck will have a total length of 262 m and a max. width of 61 m, with a total surface of 12,300 m²; the length of the angled runway will be 140 m. Two 75 m steam catapults will be fitted, one over the bow on the left of the centre line and the other across the angled runway. As the the fore catapult also crosses the runway, no simultaneous TO and landing operations will be possible. This is the result of a precise design choice, the capability to carry on simultaneous TO and landing operations having been sacrificed to more parking space.

The PAN is intended to operate a flight component of 40 aircraft, exactly the same as the CLEMENCEAUs; however, and mainly thanks to the space and weight gains offered by the nuclear propulsion, not only parking and hangar spaces but also fuel (for the aircraft) and ammunition reserves will be 50% better than the CLEMENCEAUs.

The ship will enter service with a flight component entirely made up of SUPER ETENDARDs (plus, of course, the usual helicopters for SAR). These will subsequently be replaced by the new ACMs (Avion de Combat Maritime, that is the shipborne operational offspring of ACX). As the design of the ACM is still far from being started, and as the PAN will in any case end her career around 2030 with a third generation of aircraft embarked, in order to leave a sufficient growth margin in the design, the "typical embarked aircraft" has been visualised as a 20-t twin-engine aircraft more or less similar to the F/A-18.

The possibility of a future adoption of V/STOL or STOL aircraft has also been taken into consideration. For this purpose, the bow will be strengthened with structures which could easily accept a "ski-jump". It appears that no ASW flight component (the CLEMENCEAUs have some ALIZEs) is planned.

The defensive armament is still being discussed. The model unveiled by DTCN shows two CROTALE Naval eight-cell launchers (one fore and one aft of the island) as well as what seems to be a multi-cell missile launcher on a sponson under the flight deck on the left side. Anti-missile systems will of course be fitted.

The electronics will comprise a DRBJ11B phased array 3D air search radar (also to be fitted on the AA corvettes of the GEORGES LEYGUES class), a DRBV27 long range air search radar, a DRBV15 air/surface search radar and a VAMPIR infrared panoramic surveillance system.

Supercharged diesel engines for submarines

An important breakthrough in submarine propulsion has been achieved by MTU which is now offering, for the very first time, turbocharged diesel engines for submarine propulsion.

Up to now, only naturally-aspirated engines were used for this application, mainly because of the difficulties in handling high exhaust counterpressures and intake underpressures — difficulties made even worse by the likely sudden variation of pressure during snorkel cruise. Several years ago MTU started development of small superchargers: the employment of modified exhaust turbochargers permits the adaptation of engines of the 396 family to the special requirements of submarine propulsion. At present 6-, 8-, and 16-cyl. engines with power outputs from 270 to 960 kW at 1,800 rpm are available with the designation 396 SB83.

The problem of gas and oil leaking between turbine and compressor, due to the high pressure difference in underwater operations, was solved by means of a special sealing. The increased axial thrust on the rotor — also caused by the high pressure difference — was compensated by a new axial bearing.

As compared to naturally-aspirated engines and mechanically supercharged engines the 396 SB83 features the following advantages:
— considerably reduced fuel consumption, especially at lower rpm;
— higher power concentration based on higher mean pressures;
— high degree of identical parts with series engines of the 396 family.

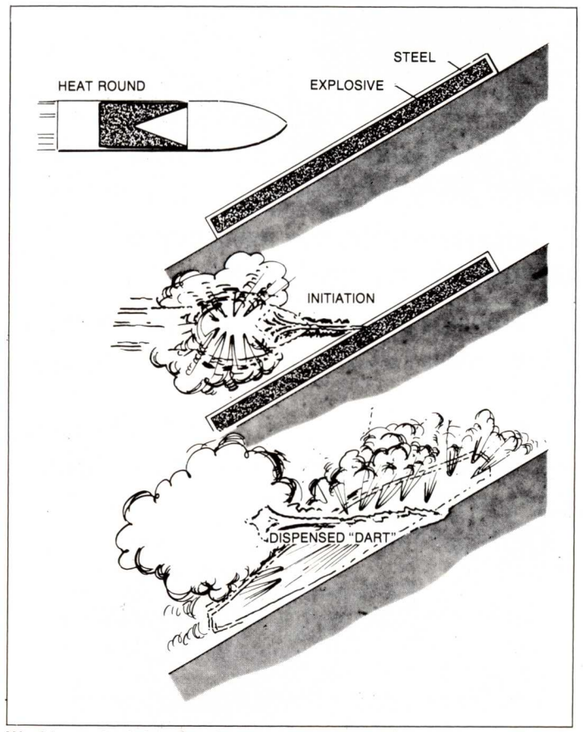
MTU reports that the company has already received the first orders for 16-cyl. engines.

New missiles for Chile

Reliable South American sources report that Chile has recently started fielding some new missiles of Western origin. The Chilean Air Force F-5E aircraft are now armed with the advanced AIM-9L version of the SIDEWINDER air-to-air missile, while the F-71 HUNTERs have been converted "Swiss style" to carry the AGM-65B MAVERICK TV-guided air-to-surface missile. In addition, Chile is discussing with Great Britain for the purchase of some batteries of RAPIER surface-to-air-missiles.

For the time being at least, we are not in a position to confirm or deny these informations; however, they come from a usually highly reliable source.

An Israeli M-60A3 MBT fitted with "add-on" active armour plates around the turret.



Working principle of active armour. The inner charge, detonated by the "dart" of the attacking HEAT warhead, blows outward disrupting the passage of the dart.

First light on the Israeli active armour

The rumours, running for some months, that during the Lebanon War the Israeli Army made the first operational use of active armour plates have now been confirmed.

Many of the AFVs used by Israeli Forces during the conflict (and in particular CENTURIONs and M-60 MBTs, as well as M-109 SP howitzers) were fitted with additional armour plates, clearly intended to increase protection against infantry AT weapons (RPG-7 and the like) during combat in built-up areas. A conspicuous exception was the MERKAVA, whose armour was judged as already sufficient; however, the MERKAVAs were fitted with chains suspended under the turret bustle to cover a dangerous "shoot trap".

It was originally assumed that these additional armour plates were "boxes" containing tiles of ceramic/plastic materials, in order to somehow "simulate" stratified armour; but it is evident that these were on the contrary active armour plates. However the possibility that *both* active armour plates and ceramic plates were used cannot be completely discounted.

The active armour plates used by the Israelis are steel boxes filled with high explosive; about 60% of the weight of the box is represented by the HE charge. When the tank is hit by a HEAT round, the latter's "flame dart" triggers the detonation of the HE charge. This detonation, blowing outward, disrupts the "dart" and prevents it from reaching the main armour plate.

As it is evident, this kind of active armour is only effective against HEAT (and possibly HESH) warheads, but not against KE rounds; active armour against APDS and APFSDS rounds would be a much more complicated affair, and would require vertically-arranged shaped-charge warheads to "cut" the KE penetrators.

Israeli reports suggest that this first operational use of active armour was not as effective as hoped, however. The principle worked well, but the Israelis were reportedly not able to completely solve the basic design problem with this kind of armour, that is, how to ensure that the HE charge is properly detonated by a HEAT warhead but not by an incendiary (or even a plain) rifle or MG bullet. It appears that in many cases the active armour plates were detonated in sequence by small arms fire.

Spanish arms export booming

According to official figures released by the Spanish MoD, Spanish exports of defence materiel have risen more than 50% in 1982. The overall figure for last year is in fact being put at around 95 billion pesetas, as against about 60 billion for 1981; in comparison with 1979, the increase of the overall export turnover of the Spanish defence industry is in the region of 300%.

European production of STINGER planned

After the first deployment of the General Dynamics FIM-92A STINGER shoulder-fired IR-homing surface-to-air missile with the US troops in Germany (April 1982), discussions started about the possible license production of the weapon in Europe and are now approaching maturity.

So far, only Germany has officially decided to adopt STINGER (the fall back choices being either the French Matra MISTRAL or the British Shorts BLOWPIPE/JAVELIN); but a strong interest also exists in Belgium, the Netherlands, Greece, Italy, Turkey and possibly Switzerland.

Two industrial consortia have already been organised in Germany, BGT/MBB and Dornier/Diehl. Both these consortia are now looking for partners in the countries which will decide to participate in the planned European programme. The proposals of the two international consortia to be so established will be evaluated, starting in summer 1984, by a European STINGER Production Group in competition between themselves and against the possible alternative of a direct purchase from the US through FMS.

Production (or purchase) of about 10,000 missiles, plus launcher and simulators, is tentatively planned.

Protests in the U.S.

Twelve persons were arrested during a ceremony marking the hand-over of the FLORIDA, the third unit of the Fleet Ballistic Missile Submarines, to the U.S. Navy, according to a report from Mönch's Washington correspondent. The twelve were part of a group of about 500 persons protesting against the submarines and the U.S. Government's nuclear weapons policies. They were arrested after gaining access to the FLORIDA during the ceremony. The protests at General Dynamics' Groton, Connecticut plant were part of a series of anti-nuclear demonstrations taking place over the weekend of 18/19 June, which included rallies in San Diego, Los Angeles, Westborough and other cities.

The FLORIDA was built at a cost of 1.5 billion U.S. dollars, and along with her sisterships the OHIO and MICHIGAN, belongs to a new class of nuclear powered submarines armed with TRIDENT missiles. This class is supposed to ultimately comprise seventeen boats. They displace 18,700 tons (f.l.), and their 24 multiple warhead TRIDENT missiles are capable of striking targets up to 4,000 nm (7,400 km) away.

Large US/Taiwan deal poses questions

The US DoD has notified Congress of its intention to sell to Taiwan, as usual through the Taiwanese Council for North American Affairs which represents Taiwan in the US, a wide range of armaments for a total value around half a billion dollars.

A proposed Letter of Offer, worth $ 291 million, will cover delivery of:

— 309 tank conversion kits to upgrade the whole of the Taiwan Army's fleet of M-48 MBTs to M-48A5 standard;
— 24 vehicle-mounted Improved CHAPARRAL surface-to-air missile systems, together with 384 MIM-72F I-CHAPARRAL missiles and an additional batch of 18 missiles for lot acceptance. The Taiwanese Army already fields 20 CHAPARRAL systems;
— 120 MIN-72F I-SEA CHAPARRAL missiles, intended for the destroyers of the AN YANG class (FLETCHER type) which were fitted with a SEA CHAPARRAL launchers some years ago.

Under a separate proposed agreement, the DoD intends to provide Taiwan with:

— 170 SM-1 STANDARD missiles and 100 AIM-7F SPARROW missiles, for a total of about $ 105 million;
— 33 M-88A1 tank recovery vehicles, for $ 54 million;
— aircraft spare parts for $ 80 million.

The proposed deals will of course trigger sharp reactions from China, and its approval by Congress cannot consequently be taken for granted.

Also, some points of the proposed sales are very puzzling from a technical point of view.

The Taiwanese Navy does not have DDGs which can fire the STANDARD in its surface-to-air role, nor is it reported to be building or buying such vessels (conversion of the 40-year old DDs into DDGs can be ruled out). So one could think of the surface-to-surface anti-ship version, with an anti-radiation homing head (RAM-66E) which is suitable for launch using the ASROC launcher. This version could be handled without problems by the Taiwanese destroyers of the CHIEN YANG and LAO YANG classes (both GEARING FRAM I) which are equipped with ASROC. However, the planned buy of 170 weapons seems far too large for this purpose. So one could think of the air-to-surface anti-radiation version of STANDARD (AGM-68D), but the Taiwanese Air Force does not have aircraft which can carry this relatively large weapon.

Even more puzzling is the SPARROW buy. Taiwan does not have, at least officially, aircraft fitted with radars compatible with radar-guided air-to-air missiles such as SPARROW. However, the delivery early this year of 66 second-hand F-104s and RF-104s of partially unknown origin (see MT 4/83 page 125) is widely believed to have comprised at least 16 F-104Ss. Developed in Italy and fitted with a NASSAR radar, the F-104S is the only version of the STARFIGHTER compatible with SPARROW; it is in service only with the Italian, the Greek and the Turkish Air Forces. As conversion of some F-104 to S standard before delivery to Taiwan appears unlikely, it is to be assumed that the Taiwanese F-104Ss did come from one of these three countries.

JOINT STARS nearing

The Westinghouse Defense and Electronics Center and Lockheed Missiles and Space Company's Austin Division have reached an agreement to team-up for bidding against Hughes Aircraft in the forthcoming JOINT STARS (Joint Surveillance and Target Attack Radar System) competition. A formal Request for Proposals for J-STARS is expected to be circulated very soon.

Readers will recall that J-STARS (formerly PAVE MOVER) is a joint USAF/US Army programme for an airborne ground target location radar, which is one of the key elements in the new "Strike Deep"/Airland 2000 doctrine for countering Soviet second echelon units (see MT 5/83 page 28 for details).

Under the terms of the agreement, if the team wins the contract Westinghouse (which has already built a prototype J-STARS/PAVE MOVER radar when the programme was still being managed by DARPA) will be responsible for overall programme management and US Army asset integration as well as for the airborne sensor package, while Lockheed will be responsible for system engineering, integration, test, and management of the data link and USAF command and control elements.

Malaysia plans indigenous production of assault rifles

The Malaysian Army and the Malaysian Government have launched a programme aimed at starting, within five years, indigenous production of an assault rifle intended to replace the M-16 currently in service. The programme is however still dependent upon whether the Government will have enough funds for it.

A special study commission, chaired by Mr. Encik Saufi Abdullah (chief executive of HICOM, Heavy Industries Corp. Of Malaysia and former Deputy Secretary General in the MoD) has already been set up. The production will come under the auspices of the National Defence Production Committee (NDPC). It appears that the idea is to reach a joint venture agreement between a foreign small arms manufacturer and HICOM, under the condition that a complete plant be set up in Malaysia.

Five firms are already submitting proposals: Steyr with the AUG, FN with the FNC, Manufacture d'Armes de St. Etienne with the FAMAS, Heckler & Koch with the HK33 and Sterling with the SAR-80. This latter weapon was developed in cooperation with Chartered Industries of Singapore, and is currently being manufactured in Singapore.

Definition contract for 3rd generation AT missiles

The Bureau Trilateral de Programmes — representing the Governments of France, West Germany and Great Britain — has awarded EMDG (Euromissile Dynamics Group: Aérospatiale, MBB and BAe Dynamics) a contract value equivalent to 25 million pounds for the definition phases of the two 3rd generation anti-tank systems to be developed to replace the current 2nd generation systems in service with the three armies (see MT 4/83 page 116).

The work under the contract has been shared equally among the three nations involved. EMDG, as prime contractor, has delegated to Aérospatiale a leading role for the medium-range infantry system (an IR beam riding missile intended to replace MILAN), to MBB for the helicopter-launched version of the long-range "fire and forget" missile and to BAe Dynamics for the vehicle-mounted version of the same missile.

The team of specialist subcontractors includes:

— Bodenseewerke Geräte Technik (Germany)
— Elektro Spezial (Germany, Philips Group)
— Eltro (Germany)
— Thomson-CSF (France)
— SEAT (France)
— SERAT (France)
— Luchaire (France)
— TRET (France)
— SNPE (France)
— Thorn-EMI Electronics (UK)
— RARDE (UK)
— ROF (UK)
— Rocket Motor Executive — PERME (UK).

Some clarifications about the Indian MiG-27 and MiG-29 programmes

Indian sources confirm that Hindustan Aeronautics is tooling up for the assembly of 200 MiG-27 FLOGGER-D ground attack aircraft, which will be delivered by the USSR in kit form. Subsequently, license production of the aircraft will be launched; this will also include license construction of the MiG-27's Tumanski R-29-300 engine, which will be manufactured by HAL at its Koraput plant.

India is the first country, after the USSR itself, to receive the MiG-27, all other customers having received the somewhat less capable MiG-23BN FLOGGER-F. India too acquired the production license of the MiG-23BN together with that of the basic fighter version, but it is now evident that the FLOGGER-F, having been replaced by the FLOGGER-D, will not be produced by HAL.

In the meantime, the strong Indian interest in the MiG-29 FULCRUM — of which we have reported on different occasions — is also confirmed. Indian sources too are now referring to the aircraft as MiG-29: it is consequently to be assumed that the former use of the "MiG-27" designation in reference to the air superiority fighter in competition with the MIRAGE 2000 for license production was a misleading manoeuvre aimed at covering the facts as long as possible.

Pakistan to get HARPOON

The US DoD is planning the sale to the Pakistani Navy of an undisclosed number of HARPOON anti-ship missiles. More details about the deal will undoubtedly be known when the proposed Letter of Offer is submitted to the Congress for approval, in the next few weeks.

It is likely that the vessels be fitted with the HARPOONs are the five GEARING-class destroyers, as they have ASROC launches modified to accept the canister launched HARPOON. Pakistan ordered a sixth GEARING-class destroyer from the US. It is also possible that the missiles are intended for the future class of light frigates/corvettes, which Pakistan has been discussing, for a couple of years, with some European and American yards.

BUSSARD programme concluded

With the successful firing of the last of the three planned rounds, the German experimental programme for the BUSSARD guided projectile has been concluded.

BUSSARD is a 120 mm mortar bomb with semi-active laser guidance and mobile control surfaces, which was developed by Diehl and Bodenseewerk on behalf of the German BMVg. It was originally planned that experiments should have continued with a more advanced BUSSARD fitted with a "fire and forget" passive IR homing head, but it is still not clear whether this programme will actually be launched.

More details on the Canadian frigate programme

As already reported, on June 29 the Canadian Government gave the final "go ahead" to the Canadian Navy's new frigate programme, by announcing its decision to award the contract for the construction of six ships to Saint John Shipbuilding & Dry Dock Ltd. Ceiling cost of the project is $ 3.85 billion Canadian dollar (at 1983/84 values), while the six vessels themselves should cost around 2.5 billion, with a ceiling cost of slightly over 3 billion. This is therefore the largest defence programme undertaken by Canada since the end of WW2.

In order to spread the workload between different Canadian companies, three hulls will be built by Marine Industries Ltd. and fitted out by Vickers Versatile Inc. Saint John, which will build and outfit the other three ships, will maintain overall responsibility for design, construction and support facilities.

The major subcontractor will be a new company, Paramax Electronics Inc., which will be established in Montreal by Sperry Inc. of US. Paramax will undertake the design, management and integration of the combat system for the new frigates; under the contract arrangements Paramax will have to be transferred to Canadian ownership during the lifetime of the programme.

The six frigates will be known as "City" class. The lead ship, HMCS HALIFAX, will be laid down in July 1985, launched a year later and commissioned in February, 1989. She will be followed by HMCS VANCOUVER in March 1990, HMCS VILLE DE QUEBEC in September 1990, HMCS TORONTO in March 1991, HMCS REGINA in September 1991 and HMCS CALGARY in March 1992.

The new Canadian frigates will have a displacement of 4,200 t, with dimensions of 133.5 x 16.4 m and a draft of 4.6 m; they will be powered by a CODOG power plant with a single Pielstick diesel engine and two gas turbines (quite probably LM2500, as G.E. of Canada is mentioned as subcontractor) for a max. speed of 30+ knots.

The weapon system will comprise a single Bofors 57 mm MkII gun (for which Canada is to our knowledge the first foreign customer), one PHALANX Mk15 CIWS, four HARPOON anti-ship missiles (the new frigates will be the very first Canadian naval vessels to carry anti-ship missiles), two Mk32 triple torpedo tube mounts, a 28-cell vertical launch system for surface-to-air missiles, and one CH-124A SEA KING ASW helicopter.

Although the Canadian press describes the vertical launch missile system as the SEA SPARROW, MT understands that no firm decision has yet been taken, and that BAe Dynamics is still pushing hard for its SEAWOLF. Readers will recall (see MT 1/82 page 110 and 4/82 page 121) that the vertical launch SEA SPARROW was originally selected by the Canadian Navy (as well as by the Dutch Navy); however, interest of both navies for this system considerably cooled down when the US Navy made it clear that it had no intention to fund its development.

On September 15, the SLAVA — leadship of a new Soviet class of guided missile cruisers, formerly known by NATO as KRASINA (see MT 7/83 page 76 for details) — passed through the Bosphorus and sailed into the Mediterranean. The gas-turbine powered cruiser, which appears to be intended to complement the larger KIROV, is the latest of the new Soviet generation of warships. A detailed analysis of SLAVA will be published in the next issue of MT. (A.P. photo)

TELEX-TELEX-TELEX-TELEX

The President of the Italian Association of Aerospace Industry, Gian Carlo Boffetta, reported at Le Bourget that Italy's export sales in this sector in 1982 had increased 22% over that of the previous year. In 1981 too, it had risen 66% over 1980. Overall, sales of the Italian aerospace industry in 1982 had increased 31%. Boffetta commented that the industry was suffering from the weak helicopter market, where Italy would have Agusta as an important producer. The Italian AMX light combat and air support aircraft, being developed in cooperation by Aeritalia, Aermacchi and Embraer, has had a good reception. Italy and Brazil have already ordered 266 of these aircraft.

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Deliveries to the Royal Malaysian Air Force of **the 44 Pilatus PC-7 TURBOTRAINERs** on order will start in February, next year, at a rate of three aircraft per month. Total value of the contract is $112 million.

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BMY will develop for the US Army **a new assault bridge** (HAB Heavy Assault Bridge) on the M-1 ABRAMS chassis. The first prototypes will be delivered in 35 months for a one-year evaluation programme.

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PISAGUA, **the last in a series of four Type 209 submarines** ordered by the Peruvian Navy from HDW in Germany, was officially delivered in June 12.

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The U.S. Army Air Defense Center and School at Fort Bliss has taken the decision to develop and produce **inexpensive drones on a large scale for air defence training.** The new drone type, designated RCMAT (Radio-controlled Miniature Aerial Target) resembles a model of the Soviet MiG-27 (FLOGGER-D), and is powered by an inexpensive engine. Currently tests are being run using a laser designator to simulate hits on these mini-drones.

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Soo Wong, Taiwan's Defence Minister, **has officially denied reports** that Nationalist China wants to take over the Schiedam shipyard Wilton-Fijenoord, which is threatened with bankruptcy. The yard belongs to RSV Rhine-Schelde-Verolme Engineers and Shipbuilders, which is building two submarines for Taiwan.

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As reported at Le Bourget, **Sikorsky Helicopters is expecting an annual growth rate of 6-9%** in the helicopter market in the coming years. This represents, in the foreseeable future, an overall volume of 24,000 to 26,000 helicopters at a total value of around $ 8.5 billion. Presently two-thirds of the world's helicopter business is military.

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The U.S. Navy is looking for **a successor to its BQM-34 FIREBEE target drones.** The Beech company is one of the bidders in the competition with its Model 997 A (BQM-PI). This drone has a wing span of 3 m, a length of 5.5 m, a fuselage diameter of 38 cm, an internal load of 90 kg and an external load of 45 kg in wing pods. The Teledyne Continental 373-8 with a thrust of 4.3 kN or the Microturbo TRI 60-2 with a thrust of 3.68 kN are two proposals for the power plant. Requirements for the new target drone are a maximum speed of 1,025 km/h at 12,000 m and a manoeuvre load factor of 7. The U.S. Navy is planning to procure 200 of this type of drone per year for the next 20 years.

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Watkins-Johnson, the American producer of electronic systems, recently announced the signing of a contract with the U.S. Air Force covering design, development, production and testing of **a land-based ESM system for the Combat Identification Program.**

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The Vereinigte Flugtechnische Werke (VFW), a separate company belonging to MBB since it split off from Fokker, **is now an integral part of Messerschmidt-Bölkow Blohm GmbH,** and is part of the MBB divisions Transport/Civil Aircraft, Space and Naval and Special Technologies.

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The NAVSTAR Global Positioning System has been given the go-ahead with a multi-year contract for **production of 28 Block II satellites.** Rockwell will deliver the satellites over five years as part of a $1.17 billion fixed price contract. 18 of these satellites belong to the navigation system and 10 are orbital reserves. McDonnell Douglas will also deliver 28 Payload Assist Modules for the same programme which will aid in inserting the satellites into orbit from the Space Shuttle or the third stage of the DELTA Carrier.

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Standard Elektrik Lorenz (SEL) is offering the following products **for equipping the German-French PAH-2 anti-tank helicopter:** a doppler navigation system based on the AN/ASN-128, the SEM-91 VHF field radio set, the AN-APR 39 radar warning system, the AN/AVR-2 laser warning system as well as adapters and computers with MIL-Bus 1553 B structure.

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Dornier GmbH reported receiving **a follow-on contract from the Government of Nigeria for delivery of 12 ALPHA JET trainers.** A previous contract had been signed in 1978 for delivery of 12 ALPHA JETs in 1981 and 1982. This new contract brings to ten the number of countries which have purchased the ALPHA JET. With total entries on the order books of 500 units, the ALPHA JET is the most widely sold aircraft of its category. By mid-1983 manufacturers in France, Belgium and West Germany had delivered almost 450 of these aircraft.

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K.D. MAHAWANGSA, **a 4,000 t ammunition ship** built by Tacoma of South Korea for the Royal Malaysian Navy, was delivered in June.

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The co-operation between Marshalls of Cambridge — Lockheed (UK)'s C-130 service centre and the MoD's design authority for HERCULES aircraft for the RAF, and Inflight Refuelling — was again displayed when the two companies announced, in a joint statement, the marketing of a package which will **add an in-flight refuelling capability to the C-130 HERCULES,** thus increasing the aircraft's effectiveness.

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A new naval ground mine — known as SEA URCHIN — has been announced by the Bracknell Division of British Aerospace. The mine, which can be triggered by any combination of change in acoustic signature, magnetic signature or change in water pressure, also has a ship counting device — a micro processor ensures that the mine will not detonate until the ship is at the optimum range. A delayed action device is fitted as is a further device which enables the mine to become sterile or inoperative after a given time. The mine may be deployed from surface vessels or, by fitting bolt on attachments, from submarines and aircraft.

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In a recent exercise involving weapons firings the question of whether the US was **going to make Egypt its new weapons test bed was raised.** Amongst numerous western weapons — Raytheon I-HAWK against Beechcraft targets pulled by the French CT.20 drones in which all missiles scored "kills" and Thomson CSF/MATRA CROTALE R 440 missiles to name but two, modified Soviet SA-7s, ZSU twin 23 mm cannons and ZSU 23-4 quadruple barrel AA guns were fired; the ZSU 23-4 computer controlled system is tracked and aimed by GUN DISH, a J band radar. The Soviet weapons were fired in a classified programme.

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The Portuguese Armed forces are to be equipped with a communications network based on the new, high technology SCI-MITAR H high frequency combar net radio produced by Marconi.

The Portuguese order is for vehicle borne 100 watt equipment that will be used for static and mobile roles. **The choice of SCI-MITAR will enable the Portuguese Army** to operate in what could well be a hostile communications environment. It is a frequency hopping system and as such is highly resistant to both interception and jamming. With the addition of a newly developed electronic counter measures module the SCI-MITAR is creating considerable interest. Already orders have been received from Sweden and Finland whilst a number of other countries are evaluating the radio.

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The Hughes **Improved TOW missiles are to be offered to the Saudi Arabians** at a cost of 26 million US dollars. The Department of Defense has notified Congress that the proposed letter of intent will involve the sale of some 2,538 missiles.

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A contract for a significant number of hand held laser rangefinders, designated LP 7, has been awarded to SIMRAD Optronics by the British MoD. The LP 7 was used extensively during the Falklands campaign and is produced for other NATO countries and under licence in Spain and the UK. It will be made in the UK by Lasergage Ltd of Hove in Sussex. The battery powered equipment weighs only 2 kg and can instantly measure ranges up to 10,000 m with an accuracy of 5 m by means of laser beams.

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Series production of the MERKAVA II MBT has now started in Israel, with the new version replacing the former MERKAVA I on the assembly line. No precise data about the characteristics of the MERKAVA II are available at the time of writing, but, according to extremely reliable Israeli sources, the tank features a 30% increase in mobility thanks to modifications to the automotive components (a new transmission, and possibly a new engine), 50% better armour (perhaps with active armour plates), latest generation night vision systems and an improved FCS with stabilised optics and slaved gun.

Work is also proceeding on the future MERKAVA III. Two possibilities are being evaluated: either a conventional turreted tank, or an advanced design with crew-in-hull and externally mounted main gun. Two different possibilities (either a gas turbine or a 1,200-1,500 hp diesel) are also being evaluated for the power pack.

We are also in a position to confirm a tentative Israeli interest in the German-manufactured 120 mm smooth-bore gun. It appears, in fact, that the Israelis are not very happy with the idea of waiting for some years till the US production line of the gun is fully active, or till a similar license production line can be organised in Israel.

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The first of the 150 SOCATA EPSILON basic trainers ordered by the French Air Force was officially delivered on July 29. Delivery rate will be stabilized at three aircraft per month in 1984.

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MT was informed by South American sources that Peru is receiving from Soviet Union **an unspecified number of Mi-24 HIND helicopters.** Some HINDs have been spotted on the military section of the Lima airport, delivered in crates and put into a flying condition at the airport. The Peruvian HINDs belong to a new version, apparently conceived for export and which bears the designation of Mi-25.

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A German decision in principle about whether **the future JF90 fighter** should be a new development or an already existing aircraft is now expected before the end of this year. The Luftwaffe is still evaluating "on paper" five foreign aircraft — the MIRAGE 2000, the F/A-18, the F-20A TIGERSHARK, the F-15 and the F-16A — but it can be expected that the final choice will be in favour of a new design to be developed in some sort of international co-operation. The decision in principle will be accompanied by the issuing of the operational requirements, and after that, things will become really "hot", with a nearly frontal clash between the ACA and the ACX. Although a really comprehensive European co-operation programme (Germany/France/U.K./Italy, perhaps also extended to Spain) is still the preferred aim, there are indications that Germany will have to choose between France and U.K. The Luftwaffe is reportedly inclining towards France because of the rather similar operational requirements, while the industry (MBB) would prefer co-operation with the U.K. in order to exploit the good links already established with the TORNADO programme, keeping Panavia alive.

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The British Secretary of State for Defence, Mr. Heseltine, has announced that tenders have been requested for **the building of two Type 22 "Batch three" frigates.** One of these frigates was already planned in the White Paper issued after the Falklands war (see MT 3/83 page 85), whereas the second would be an additional unit beyond those already authorized; this would bring the strength of the class to 14. The yards invited to tender are Cammell Laird, Swan Hunter and Vosper Thornycroft; Yarrow was not invited because it is already very busy with the Type 22 programme (the yard has built or is building the first eight units of the class, and won the order for the first two "Batch three" vessels).

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Westland has received orders from the British MoD worth about 24 million pound for 15 helicopters: three SEA KING Mk3 for the RAF and 12 LYNX, three for the RN and 12 for the Army. The three SEA KINGs are the SAR version. Both the Navy and Army LYNXs will have the uprated GEM 41-1 engine, developing 1,120 shp against 900 shp of the GEM 2 presently fitted.

The first SEA KING is due for delivery in March 1985 with the other two following in April and May. Deliveries of the Navy LYNXs will start in November, next year, and the first Army LYNX will be delivered in January 1985.

This latest batch brings the number of new helicopters ordered by the British Government from Westland in recent months up to a total of 31.

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The Royal Malaysian Navy has awarded a contract worth $100 million for the construction of **two 1,300 t offshore patrol vessels.** The first vessel will be built at the Korean Shipyard & Engineering Co. and delivered in April, 1985; the second unit will be built by September, 1985 at the Johore yard of Malaysian Shipyards Engineering. The original programme called for four vessels, but financial restrictions reduced the order to two.

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The US programme of military assistance to the Lebanese Army continues. The DoD has informed Congress about a proposed Letter of Offer for **the sale to Lebanon of 68 M-48A5 MBTs;** total value of the contract, including spares, ammunition, training etc., is in the region of $64 million. The tanks, which will be taken from the US National Guard reserve stocks, will equip two armoured battalions of the Lebanese Army. Readers will recall that the sale of a first lot of 34 M-48A5s was approved late last year (see MT 2/83 page 88).

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The Indian Army is purchasing about 250 L-60 6-cyl. multi-fuel engines from British Leyland; a first batch of around 100 engines has already been ordered, while the remaining 150 should follow in the near future. The L-60 powers the Indian VIJAYANTA MBT (basically a Vickers 38 t Mk1), about 1,000 of which are in service; many of these vehicles are now in need of a new power plant, and although the L-60 is also manufactured under license in India the production output is reportedly not sufficient to cope with the demand. Production of the VIJAYANTA was recently stopped in favour of the T-72.

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The first TORNADO F.2 for RAF Germany flew into RAF Laarbruch from St. Athan in mid-August. The aircraft will be used for training and maintenance familiarisation of engineering ground crews before the official formation of No. XV Squadron in September.

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The Indonesian aircraft company PT Nurtanio has reached an agreement with MBB and Kawasaki Heavy Industries for **license production of the BK-117 transport helicopter,** jointly developed by MBB and KHI.

A first production run of 100 Bk-117s is planned.

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The Egyptian Minister of Defense has officially announced that next year indigenous production of **the Soviet SA-7 STRELA (GRAIL) surface-to-air shoulder-fired missile system** will start. The Minister did not elaborate whether this is a "regular" license production agreement with USSR (which seems highly unlikely) or whether Egypt is simply copying the weapons it has.

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Smith Industries Aerospace & Defence Systems Company has been selected to provide the autonomous navigation system for the Ferranti entry into the British Army's PHOENIX programme, aimed at development of reconnaissance/target acquisition mini-RPV. The Smith Industries navigation system comprises a low-cost strapdown attitude and heading reference which utilizes the latest gyroscope and accelerometer technologies, together with air data and navigation computation.

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The United States plans to sell Saudi Arabia 100 M-60A3 MBTs, at a total cost of $176 million. This is the first major sale of US armour to Saudi Arabia under the Reagan Administration. The Saudis already have 150 M-60A1 tanks, which are being converted to M-60A3 standard with conversion kits ordered in July, 1980.

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The US Army and the German Army had agreed to paint all their AFVs with **a new three-tone camouflage scheme,** originally developed in Germany. A report will follow in one of the next issues of MT.

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Italtel of Italy has won an Australian Air Force competition for an IFF equipment, to be retrofitted on the Aermacchi MB-326 trainers, and installed on the P-3Cs and F/A-18 HORNETs as they are ordered. The IFFs will be manufactured under license by Rockwell Collins (Australasia) Pty. Ltd, which has also be granted the right to export them to other potential customers in the region.

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A decision is expected soon for **the ASW helicopter to be embarked onboard the Australian ADELAIDE-class frigates** (FFG-7 design). The four contenders are the Sikorsky SH-60B SEAHAWK LAMPS III, the SA-365F DAUPHIN, the navalised version of the SUPER PUMA and the Westland NAVY LYNX. Although the RAAN would of course like the SH-60B, its cost seems to have ruled it out; the most likely choice is probably the DAUPHIN.

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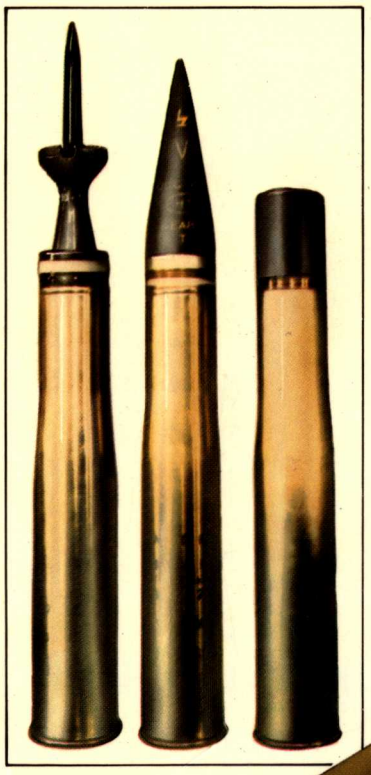
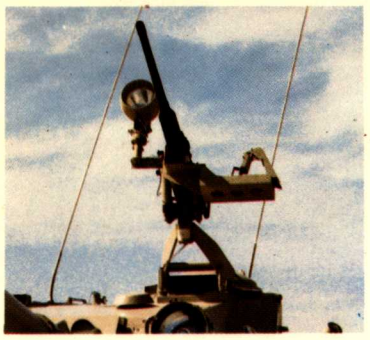
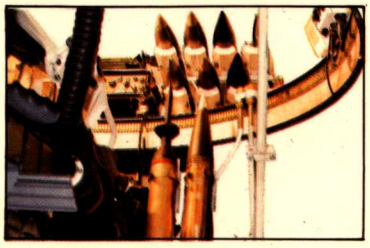
TS90 a multi-mission weapon system.



- outstanding fire-power notably against armour due to **dart ammunition**
- plus ground support role with **enhanced H.E. ammunition**
- multi-mission deployment based on **wide range of ammunition types**
- maintenance facilitated by proven **modular construction**





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